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Validation of an Instrument to Measure the Change in Ecological Vocabulary of Teachers Attending Texas Environmental Education Advisory Committee Endorsed Programs

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by

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ABSTRACT

An instrument was developed and evaluated for measuring the effect of the Texas Environmental Education Advisory Committee (TEEAC) endorsed teacher inservice programs on participants' ecological vocabulary. Principal study objectives were to establish a basic ecological vocabulary essential to environmental education and evaluate the instrument's effectiveness in measuring change in participants' ecological vocabulary resulting from exposure to TEEAC programs.

The Ecological Vocabulary Survey (EVS) was developed from 57 ecological terms. A comparison of EVS terms with terms selected by ecological and environmental education organizations indicated the EVS terms were essential to environmental education.

A total of 148 matched pairs of pre and post survey instruments were tested by 9 TEEAC programs during the summer of 1994. Results indicate the EVS was successful in measuring a change in ecological vocabulary, recording a significant increase in correct responses from 65.04% of the pre test to 80.63% of the post test.

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I thank the Texas teachers and environmental educators participating in the study, and members of the Texas Environmental Education Advisory Committee. These dedicated people provided the concept and motivation for the study topic. My hope is that the study results clarify and enhance their efforts.

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INTRODUCTION

Environmental Education and Ecology

April 22, 1990, the twentieth anniversary of Earth Day, marked a renewal of America's concern for the environment. In Texas, one result of this concern was an increased interest by teachers, lawmakers and the public in integrating environmental education into public school curricula. While most Texas universities require basic life science coursework, there is no preservice environmental education teacher training requirement. Also, there is no assurance that environmental education inservice programs provide teachers with comprehensive environmental education knowledge, skills, and techniques because there are no standard program evaluation tools.

This study focused on the changes in the ecological vocabulary of teachers participating in environmental education inservice programs. The objectives of the study were to:

- Establish a basic ecological vocabulary
- Evaluate the effectiveness of an instrument measuring the extent of change in participants' ecological vocabulary resulting from exposure to Texas Environmental Education Advisory Committee (TEEAC) endorsed programs
- Evaluate the effectiveness of the instrument in gathering various demographic and antecedent variables (such as previous

environmental education coursework, educational experience, etc.) which form relationships with participants' knowledge levels.

Unfortunately, much of the environmental education practiced in this country's schools has little or no theoretical background and lacks consistency and comprehensivenss (Ramsey et al. 1992). Hendee (1972) voiced concern that environmental education programs often lack a scientific (e.g., ecological) foundation and have been guided primarily by "emotionally derived truths". He proposed that the goal of bringing about informed environmental policies throughout society can be accomplished by first transmitting knowledge and facts and, subordinate to that, changing attitudes, values, and cultural perspectives toward the environment and stimulating social action. Nichols (1992) stated that in teaching environmental education, pseudoscientific beliefs and stereotypes should be discarded and pure scientific tenets should be exemplified. London (1984) emphasized that "misleading and unsubstantiated arguments" comprised much of the environmental education curricula and Poore (1993) concurred, citing an emphasis on environmental action instead of a science background.

Incongruently, environmental education definitions, goals, research and programs appear to be committed to furthering the development of ecological literacy. Environmental education definitions and goals at the state, national and international levels have a common reference to knowledge, or understanding, of our environment (United Nations Educational, Scientific, and Cultural Organization 1978, U.S. Senate 1990, Texas Environmental Education Advisory Committee 1993).

Environmental education researchers repeatedly cite the importance of ecological literacy within environmental education (Ramsey and Rickson 1976, Clark 1975, Ritz 1977, Hungerford and Volk 1990). In a national survey of public school environmental education programs, Childress (1978) found that classical ecological knowledge was rated highest among the primary program objectives. From these perspectives, ecology is a critical component of environmental education. Why then, is environmental education criticized for having little or no scientific ecological foundation? The answer lies with the principal implementor of environmental education, the teacher.

Classroom teachers must play an integral role in any environmental education program. Without the classroom teacher's enthusiastic participation, an ongoing environmental education program is severely handicapped (Simmons 1988). However, enthusiastic participation is not enough to ensure that environmental education is done correctly, specifically with a scientific foundation.

Ham and Sewing (1987) reported that most teachers using environmental education in a region of eastern Washington and western Idaho emphasized ecological principles in class. However, the teachers also stated they were not completely comfortable with their training or preparation to teach environmental education, primarily because of their lack of a ecological background. In several other studies, classroom teachers themselves have recognized that one of the major constraints to teaching environmental studies are inadequate academic preparation (Johnson 1980, Lane et al. 1994). In their assessment of the environmental science status in Texas public schools, Adams, et al. (1985) identified teachers as the primary implementors of environmental science and recommended that they receive more environmental science and education inservice training. This recommendation is echoed by many environmental education researchers (Cherif 1992, Lane 1994, Pettus and Schwabb 1978, Hounshell and Liggett 1976).

Because there is no environmental education training requirement for preservice teachers in Texas, almost all teachers receive environmental education training through inservice workshops. Presently, these workshops are conducted at sites and programs endorsed by The Texas Education Agency (TEA) appointed Texas Environmental Education Advisory Committee (TEEAC).

The Texas Environmental Education Advisory Committee

History and Mission of TEEAC

In May, 1991, the 72nd Texas Legislature passed Senate Bill 1340, the Texas Recycling Act. The general purpose of this legislation is "relating to recycling programs and incentives; creating offenses and providing penalties." Section 10 of S.B. 1340 amends the Texas Education Code by adding Section 11.53, which states: "The commissioner of education shall foster the development and dissemination of educational activities and materials which will assist Texas public school students, teachers, and administrators in the perception, appreciation, and understanding of environmental principles and problems." To accomplish this goal the commissioner of education, through the Texas Education Agency, is mandated to:

- Encourage infusion of environmental topics into regular curriculum
- Coordinate funding, solicitation and dissemination for instructional material and teacher inservice programs
- Collect, evaluate, and disseminate instructional material
- Prepare an annual status report

It is worth emphasizing that TEA must "encourage the infusion of", but is not mandated to require environmental education in public schools. Also it is worth noting that the legislation did not provide for any funding or staffing.

Section 11.53 also established the Texas Environmental Education Advisory Committee, officially formed in late 1991. TEEAC members represent state agencies, environmental and environmental education organizations, and teacher organizations. Of the four TEEAC subcommittees, the Teacher Education Standards Subcommittee oversees the education of teachers in environmental education (Texas Education Agency 1992).

Many tasks have been accomplished by the volunteer members and its affiliated endorsed programs, despite having only one full-time coordinator and no legislated funding. Program standards have been established, teacher inservice programs endorsed and implemented; an ongoing list of environmental education resource material has been compiled, reviewed and made available to teachers; and some funding has been found. One task that remains is to evaluate the ongoing teacher education programs (Texas Education Agency 1995).

Teacher Inservice Programs

The Teacher Education and Standards Subcommittee of TEEAC is charged with making recommendations to TEEAC on inservice programs and sites. Of critical importance to this study, the subcommittee is responsible for establishing and evaluating the environmental education content and curriculum framework for endorsed programs (TEEAC 1992).

Program endorsement by the subcommittee is based on the program's ability to educate and impart instructional strategies to teachers in two content areas: ecological principles and humanity's interaction with the environment. The experiences offered by programs must be multidisciplinary, include "hands-on" participatory or field experiences, and must educate participants about the local ecology and environmental issues. It should be noted that the subcommittee established, but did not dictate, environmental concepts and issues taught by endorsed programs. Endorsed programs are usually site-based, conducted at zoos, museums, nature and environmental education centers, and universities across the state. A program may be 3 to 45 hours in length. Endorsed programs submit their program dates, location and program description to the TEEAC for distribution through the TEA communication network. Endorsed programs are then responsible for registering participants, implementing and evaluating the program, and awarding the participants with TEEAC recognition credit (TEEAC 1992).

Teachers accumulating up to forty-five contact hours at endorsed environmental education sites and programs receive a document of formal TEEAC recognition. Also, principals and administrators associated with recognized teachers are informed by TEEAC of the teachers' accomplishment.

LITERATURE REVIEW

Environmental Education Defined

The credibility of this study is based upon the relationship between ecological vocabulary, ecological knowledge and environmental education. Evidence of this relationship is found in environmental education definitions, goals and research.

Delegates assembled at the 1977 United Nations Intergovernmental Conference in Tbilisi, Georgia, USSR, agreed upon the following definition of environmental education:

> Environmental education is a process of developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, skills, attitudes, motivation and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones (United Nations Educational, Scientific, and Cultural Organization 1978).

In the United States, the National Environmental Education Act of 1990 defined and outlined support for environmental education. Concepts included in the definition are that environmental education is intended to promote an awareness and understanding of the environment, the wise use of natural resources and the recognition and acceptance of personal responsibility in decision-making and stewardship toward the environment (U.S. Senate 1990).

Borrowing from these definitions, the Texas Environmental Education Advisory Committee defines environmental education as "a process that promotes awareness, understanding and responsible decision making regarding humankind's relationships in the environment." (TEEAC 1993).

In each of these definitions, knowledge and understanding of the environment is directly or indirectly implied as a principal component of environmental education. However, ecology must not be equated with environmental education or with environmental education goals (Hungerford 1975).

Most environmental education professionals agree that their ultimate goal is the involvement of citizens in understanding, solving and preventing environmental problems. Roth (1968) initially applied the term "environmental literacy" to this involvement and stated that the goal of environmental education was to produce environmentally literate citizens who were properly informed to be able to read their environment, diagnose its ills, apply first aid when needed, and bring in experts to handle more complex problems. Disinger and Monroe (1994) distinguished environmental literacy from other literacies by its action perspective of perceiving and interpreting environmental health and taking appropriate action. They further noted that while most literacies are measured in terms of cognition, the measures of environmental literacy challenge the assumption that behavioral change follows directly from the development of necessary knowledge and skills. This seemingly places environmental literacy, and environmental education, at odds with the traditional educational goals of knowledge, understanding and skill development.

However, another perspective is that environmental education incorporates traditional education goals, including knowledge and understanding. Reflecting this perspective, a substantive framework has been developed by Hungerford, Peyton, and Wilke (1980). Their framework involves four distinct levels, incorporating traditional educational goals while contributing to environmental literacy development. Level One is a broad framework of ecological concepts. Levels Two, Three and Four are: Conceptual Awareness; Issue Investigation and Evaluation; and Environmental Action Skills. The sequential priority of achieving these environmental education goals places primary importance on ecological knowledge.

Ecological Vocabulary

Literature was reviewed for lists of ecological vocabulary terms. Ballard and Panya, working with the North American Association for Environmental Education, compiled a database for building environmental education activities and programs (North American Association for Environmental Education 1990). The 600 concept database was divided into 3 main sections: Natural Systems; Resources; and Human Systems. Each section contains four or five subsections with about 50 concepts each, and the subsections contain 43 categories, each with 10 - 20 concepts. The concepts are coded and cross referenced with other concepts, learning levels, and teaching objectives.

Cherrett (1989) conducted a survey of British Ecological Society (BES) members to produce a checklist of "the 50 most important ecological concepts." One objective of the checklist was to provide a curriculum development tool for educators, particularly educators who are uncertain about which (ecological) principles should be covered.

Much of the literature relating ecology to environmental education contained vocabulary terms within broad conceptual statements. Hungerford et al. (1980) established goals for environmental education curriculum development, recommending 9 conceptual components as the minimum for their Ecological Foundations Level. The components were comprised primarily of broad ecological concept combinations such as "Individuals and Populations" and "Interactions and Interdependence." Two of the components included humans and human activities, which were outside the scope of this study.

In a report on the United Nation's International School's curriculum for the conservation of people and their environment, Brennan (1986) listed 3 conceptual schemes with 250 supplementary concepts of the environment. However, there were relatively few (19) specific ecological terms.

Instruments and Inservices

Instruments Measuring Knowledge Acquisition

One study focused on the development of an instrument measuring the concept of ecology. Zosel (1978) utilized a panel of experts to develop 50 item multiple choice tests to be used in assessing concepts of ecology held by fifth/sixth grade samples. Item responses were factor-analyzed, and resulted in the identification of eighteen factors associated with the concept of ecology. This study, however, focused on children's concepts of what ecology is, not their gain in ecological knowledge.

Dunn (1979) developed and tested a self-paced ecology unit for University of Southern Mississippi students. He developed a 54 question multiple choice examination on a pre-post test format. Most students completed the ecology unit in five hours. The mean score on the pre test was 26.61, significantly increasing to 45.66 on the post test. Based upon these and other findings he concluded the test was reliable and valid. His ecology unit and test were specifically related to marine ecology, rather than general ecology.

Teacher Inservices

Bethel and Hord (1982) conducted an evaluation of a National Science Foundation program aimed at improving science teaching in grades K-12. Their needs assessment study revealed that south Texas teachers were very much interested in environment-related concepts, including ecosystems, environments and Texas ecology. From this needs assessment, an inservice program was developed and a study was designed to obtain formative and summative evaluation data, including data on the environmental science knowledge gained during the inservice program. The knowledge instrument format was multiple choice and was administered to control and experimental groups in a pre-post test design. Pre test scores indicated no significant differences in environmental science knowledge between the two groups. At the conclusion of the inservice program there was a significant improvement in the pre and post test scores of the experimental group and a significant difference in post test scores between the two groups. The conclusion was made that the inservice program did have a significant effect on the participants' knowledge of environmental science concepts. The researchers noted the lack of technically accurate diagnostic instruments needed to design and implement relevant staff development programs.

Milson (1975) studied the effect of an environmental education symposium on teachers designed to assist teachers in developing the content knowledge necessary to understand and select positions on various environmental problems. Prior to the symposium, the study indicated that the teachers were concerned about their lack of ecological knowledge and ability to select environmental topics which would be appropriate to their discipline. After the symposium, teachers indicated that they would include a greater amount of environmental related materials in their classrooms.

One study focused on the relationship between the change in environmental knowledge and attitudes of inservice teachers and the resulting knowledge and attitude change of students. In this study, Hounshell and Ligget (1976) measured the change in environmental knowledge of 6th grade students after their teachers had participated in an environmental education inservice program. There was significant gain in teachers' knowledge and a gain in student knowledge, noting that the students were actually a secondary treatment group.

Some of the literature on the ecological knowledge aspect of environmental education teacher inservices dealt with the effect of knowledge acquisition on attitudes. Ham et al. (1987) conducted an inservice workshop to reduce barriers which inhibit teachers from conducting environmental education, including the barrier stemming from teachers' apprehension about the suitability of their ecological background. Instead of measuring knowledge of ecological concepts, the researchers measured the workshop participants' perception that lack of knowledge created a barrier to teaching environmental education. To reduce this barrier, the workshop provided environmental education material that required little preparation time and was geared toward elementary age groups. The workshop emphasized that a science background is not necessary to conduct effective environmental education programs and teachers were motivated to depend upon the knowledge they already possessed. Results indicated that the workshop did significantly decrease the knowledge barrier perception. In a similar study, Jaus (1978) researched the relationship between ecological knowledge gain and teachers' attitudes towards teaching environmental education. He studied 51 elementary and middle school teachers assigned to one of two in-service science methods classes. The experimental group was provided with predominantly ecology-based instruction. The researcher utilized a 50 item multiple choice test to assess ecology concept acquisition, and a three section, thirty item questionnaire to determine teacher attitudes toward teaching environmental education. Following instruction, concept acquisition and attitudes toward teaching environmental education were assessed. Those receiving ecology-based instruction scored 85% or better on the cognitive test and showed significantly greater positive attitudes toward teaching environmental education. Ritz (1977) reported on two inservice designs used at Syracuse University which were specifically planned not to be "science dominated." His contention was that an over-emphasis on environmental science risked shutting out teachers who might otherwise be ready to get into environmental education. One of the workshop designs focused on the teachers' personal growth with respect to understanding the environment, de-emphasizing knowledge acquisition. The other workshop design focused on environmental education methodologies. Although no research was conducted, he reported enthusiastic teacher involvement.

Roberson (1992) surveyed participants of the American Wilderness Leadership School, a Wyoming-based field oriented program emphasizing conservation education. He conducted a pre and post test to measure changes in opinions on natural resource management issues and knowledge of general and wildlife ecology and ecology of the Yellowstone National Park ecosystem. Following the program, overall scores of the 149 participants increased significantly, with significant increases in correct responses to 18 of the 27 ecology statements. Eight of the 27 statements tested participants' knowledge of general ecological vocabulary. All 8 of these statements contain vocabulary terms used in this study.

METHODS

Participating TEEAC Endorsed Programs

Twenty TEEAC sites, offering a total of 40 endorsed programs during the months of June, July, and August, 1994, were contacted and solicited to participate in the Ecological Vocabulary Survey (EVS). These months were selected because of the number and variety of TEEAC endorsed programs offered. Four program sites agreed to implement the survey during a total of 9 programs. The main reason other sites gave for not participating was lack of time due to the length of the survey. A description of the participating sites and their programs follows.

<u>Site 1 Piney Woods Conservation Center (PWCC)</u>

The PWCC, part of the Stephen F. Austin State University College of Forestry, is a regional environmental education center on the shores of Sam Rayburn Reservoir. In cooperation with the Texas Forestry Association, the PWCC hosts 3 one-week TEEAC endorsed teacher education programs entitled the Teacher's Conservation Institute (TCI). A total of 89 TCI participants earned 18 TEEAC hours during a three-part program of Project WILD, Project Learning Tree, and forestry related field trips. Eighty-two participants completed the EVS.

<u>Site 2 River Basins Institute (RBI)</u>

Based in the northeast corner of Texas, the RBI conducts regional science education programs in collaboration with wood products industries, state and national natural resource agencies and local school districts. A total of 15 RBI participants earned 12 TEEAC hours during a program entitled "Caddo Lake: A Living Laboratory." The program covered environmental science, science processes and water quality monitoring. All of the RBI participants completed the Ecological Vocabulary Survey.

Site 3 Colorado Soil and Water Conservation District Seminar (CSWCD)

The CSWCD Seminar, conducted near the Colorado River in southeast Texas, was designed to expose teachers to outdoor learning situations including aquatic, terrestrial, wildlife, and soil studies. A total of 15 participants earned 15 TEEAC hours during the "Outdoor Learning - Extending the Classroom Outdoors" program. All of the seminar participants completed the Ecological Vocabulary Survey.

Site 4 New Braunfels Parks and Recreation Department (NBPRD)

The city of New Braunfels, through the Parks and Recreation Department, offered 6 separate 6 hour TEEAC endorsed programs. These included 2 Project WILD and 2 Aquatic WILD programs, an OBIS program, and a Project Learning Tree program. Thirty-six out of 39 participants completed the Ecological Vocabulary Survey.

Test Design

Data was collected using pre-post test instruments. The instruments consisted of a fill-in-the-blank question form requesting demographic information and pre and post program statement forms testing ecological terms.

The ecological testing instrument was divided into two sections, one of 16 matching statements and one of 41 multiple choice statements. This test design was chosen to accommodate the time constraints of the program facilitators and the ease of test taking by the participants. Responses to statements were recorded by participants on General Purpose - NCS - Answer Sheets (form no. 30423) which could be scanned by computer. To facilitate ease of test taking each matching statement had 4 foils and one "I don't know" selection and each multiple choice statement had 3 foils and one "I don't know" selection. The "I don't know" selection was added to help prevent guessing.

Sampling Procedure

Both pre and post test forms were completed at the participating TEEAC endorsed program sites. The pre-test instrument recorded demographic information and pre-program ecological knowledge levels of program participants. The post test recorded post-program knowledge levels. At the completion of each program, the program facilitator(s) completed a third test form indicating which post-test questions they believed the participants should be able to answer on the basis of their instruction.

Due to various factors, including early departures and unwillingness to take the tests, 148 out of a potential 158 matched pairs of pre and post program survey instruments were used in the study.

Survey Instruments

Both pre and post program survey instruments were developed to collect data for the study (Appendix A). A list of 87 ecological terms were compiled from Smith's *Elements of Ecology* (1992), Miller's *Living in the Environment* (1988), and the Project WILD and Project Learning Tree activity guides. The goal of the term selection process was a comprehensive list of basic ecology terms, essential to environmental education, from which a test instrument of reasonable length could be produced. The term selection objectives were to develop a vocabulary list which was:

- Ecologically comprehensive but limited to specific terms describing natural systems.
- "Teacher friendly." Non-scientific terminology was used when possible and the length of the test was considered.
- Applicable to TEEAC programs. Terms which could be applied to the diverse Texas biomes were given priority. Also the amount of time needed to administer the test was considered.

The ecological vocabulary list was reviewed by a panel of four college professors, including ecologists, and teacher education specialists. The panel was selected based on their expertise in ecology, teacher education and environmental education. The list was also mailed, in survey form, to all TEEAC endorsed programs. Program facilitators were asked to indicate whether each term was fully, partially, or not defined during their programs.

Based on the responses of the professorial panel and the TEEAC program survey, a revised list of 57 ecological terms was used to develop an ecological vocabulary test. The survey instrument, including the vocabulary test and a demographic survey, was reviewed by the professorial panel and two Texas state certified teachers, and changes were made according to their advice. These instruments were then tested on the participants of the first TCI program. Based on the responses of these participants, no further revisions were necessary.

Statistical Analysis

The data collected were analyzed for frequency of response in order to obtain demographic characteristics. One-way ANOVA, t-tests and multiple t-tests were administered to detect significance of differences in response due to demographic characteristics.

RESULTS AND DISCUSSION

Establishing an Ecological Vocabulary

Ecology Term Selection

A total of 87 ecology terms were selected and reviewed by an expert panel of ecologists and teachers. The goal of the term selection was to develop a basic ecological vocabulary, essential to environmental education, which could be used to measure changes in the ecological vocabulary of TEEAC participants.

TEEAC programs were surveyed to ascertain which of the 87 terms were fully, partially, or not defined during their programs. A total of 65 TEEAC sites were solicited for a survey response. Of the 30 sites (46.15%) responding, six had multiple programs. Therefore, the total survey response represented 47 TEEAC endorsed programs.

Using the data from the TEEAC program survey, 57 terms were selected for developing the test instrument, the Ecological Vocabulary Survey. The EVS terms were compared to two standard lists of ecological terms and the ranked TEEAC program terms. The standard lists of terms were established by environmental educators from the North American Association of Environmental Education (NAAEE) and by professional ecologists from the British Ecological Society (BES). Table 1 displays the result of this comparison. The TEEAC survey list was considered the most comprehensive, therefore these terms are listed first along with the percentage of TEEAC programs utilizing them. The EVS, the NAAEE and the BES lists could then be compared to the TEEAC rankings. Obviously, all of the EVS terms matched the TEEAC survey, therefore the EVS terms were compared and ranked by the highest number of matches with the BES and NAAEE lists. Overall, 52 of the 57 EVS terms (91.23%) matched terms in either the BES or the NAAEE lists and were selected by an average of 47.54% of the TEEAC programs. Twenty-five of the EVS terms (43.86%) matched both the BES and NAAEE lists and were selected by an average of 54.27% of the TEEAC programs. Twenty-two of the EVS terms (38.60%) matched only the NAAEE lists and were selected by an average of 47.08% of the TEEAC programs. Five of the EVS terms (8.77%) matched only the BES list and were selected by an average of 30.55% of the TEEAC programs. Five of the EVS terms did not match either the BES or the NAAEE lists and were selected by 32.84% of the TEEAC programs.

Munson (1994) asserted that the 20 highest ranked concepts, of the 50 total BES concepts, would be recognized and endorsed by most environmental educators as essential to environmental literacy. Indeed, 17 of these 20 concepts matched terms on the EVS. However, only 12 of the remaining 30 BES concepts matched EVS terms, most likely because the BES survey determined the 50 most important ecological concepts to scientists, not educators. On the other hand, 47 terms from the NAAEE list, developed specifically for environmental educators, matched terms on the EVS.

Table 1. Ecological vocabulary terms ranked by TEEAC endorsed programs and compared to Ecological Vocabulary Survey (EVS), North American Association for Environmental Education (NAAEE), and the British Ecological Society (BES).

No.	Vocabulary Terms (from TEEAC)	TEEAC (% ranking)	EVS	NAAEE	BES
1	adaptation	95.65	X	X	X
2	food chain	85.11	X	X	X
3	ecosystem	82.98	X	X	X
4	community	80.00	X	X	X
5	prey	74.47	X	X	X
6	herbivore	74.47	X	X	X
7	food web	72.34	X	X	X
8	predation	70.21	X	X	X
9	competition	68.89	X	X	X
10	biodiversity	66.67	X	X	X
11	species diversity	66.67	X	X	X
12	niche	59.57	X	X	X
13	carrying capacity	58.70	X	X	X
14	indicator species	44.68	X	X	X
15	keystone species	44.68	X	X	X
16	limiting factor	43.48	X	X	X
17	energy flow	42.22	X	X	X
18	productivity	35.56	X	X	X
19	succession	34.04	X	X	X
20	parasitism	31.91	X	X	X
21	biome	30.43	X	X	X
22	biosphere	28.89	X	X	X
23	evolution	28.26	X	X	X
24	trophic	24.44	X	X	X
25	biogeochemical cycle	13.04	X	X	X
26	habitat	95.74	X	X	
27	environment	91.49	X	X	
28	ecology	76.09	X	X	
29	population	73.33	X	X	

continued

Table 1. Ecological vocabulary terms ranked by TEEAC endorsed programs and compared to Ecological Vocabulary Survey (EVS), North American Association for Environmental Education (NAAEE), and the British Ecological Society (BES).

No.	Vocabulary Terms (from TEEAC)	TEEAC (% ranking)	EVS	NAAEE	BES
30	decomposer	72.34	X	X	
31	extinction	69.57	X	X	
32	carnivore	68.89	X	X	
33	omnivore	55.56	X	X	
34	photosynthesis	53.33	X	X	
35	climate	47.83	X	X	
36	indigenous species	44.68	X	X	
37	nutrient	39.13	X	X	
38	symbiosis	38.30	X	X	
39	abiotic (non living)	36.17	X	X	
40	natural selection	35.56	X	X	
41	endemic	32.61	X	X	
42	biomass	28.89	X	X	
43	selection	26.09	X	X	
44	edge effect	19.57	X	X	
45	biological magnification	13.04	X	X	
46	macro/micro nutrients	10.87	X	X	
47	homeostasis	6.67	X	X	
48	species (threatened, endangered)	64.44	X		X
49	resource (renewable and non-renewable	57.45	X		X
50	sustained yield	15.56	X		X
51	keystone species	10.87	X		X
52	density independent/dependent	4.44	X		X
53	indigenous	55.32	X		
54	fauna/flora	51.11	X		
55	mutualism	22.22	X		
56	nutrient cycle	17.78	X		
57	entropy	17.78	X		
58	territory	48.94		X	
59	water cycle	45.65		X	

continued

Table 1. Ecological vocabulary terms ranked by TEEAC endorsed programs and compared to Ecological Vocabulary Survey (EVS), North American Association for Environmental Education (NAAEE), and the British Ecological Society (BES).

No.	Vocabulary Terms (from TEEAC)	TEEAC (% ranking)	EVS	NAAEE	BES
60	migration	36.17		X	
61	heterotrophic	11.11		X	
62	eutrophication	8.89		X	
63	ecotype	13.33			X
64	r-species	4.55			X
65	k-species	2.27			X
66	interdependence	56.52			
67	evaporation/evapotranspiration	47.83			
68	precipitation	45.65			
69	range of tolerance	30.43			
70	growth rate	28.89			
71	greenhouse effect	28.26			
72	tolerance limit	28.26			
73	nitrogen cycle	21.74			
74	weathering	20.00			
75	drought (avoidance, resistance, tolerance)	19.57			
76	oxygen cycle	17.78			
77	stability	17.78			
78	commensalism	17.78			
79	gene pool	17.39			
80	dominance (ecological, social, and genetic)	14.89			
81	stratification	14.89			
82	biochemical oxygen demand	13.33			
83	carbon cycle	13.04			
84	phosphorus cycle	9.09			
85	law of conservation of matter	8.89			
86	law of tolerance	8.89			
87	laws of thermodynamics (1 & 2)	8.70			
88	ecological efficiency	6.82			
89	genotype	4.35			

Descriptive Characteristics of TEEAC Participants

General Descriptive Characteristics

General descriptive variables included sex, age, and ethnicity. Responses to this portion of the survey are found in Table 2. A large percentage of the workshop participants were white, female teachers. Among the 148 participants surveyed, 13% were between 20 and 40 years of age, 49% were between 41 and 60 and, 38% were between 61 and 80 (Figure 1). The sex ratio was a little over 5:1, predominately women, with 24 males (16%) and 124 females (84%). Most participants were Caucasian (89.2%) with the remaining participants African American (1.3%), Hispanic (2.7%), Native American (4.1%), and other (2.7%), including one biracial and one Pacific Islander. The lower percentage of minority participants may be related to traditionally low participation rates among minority teachers in environmental education.

Participants indicated their education affiliation when asked the grade level and subjects they taught. Most respondents indicated they were employed as teachers (82.40%). The education affiliation of the other respondents included Students (5.40%), Librarian (1.35%), Principal/Administrator (1.35%), and Scout Leader (5.41%). A small portion (4.73%) of the participants did not respond.

Educational Background

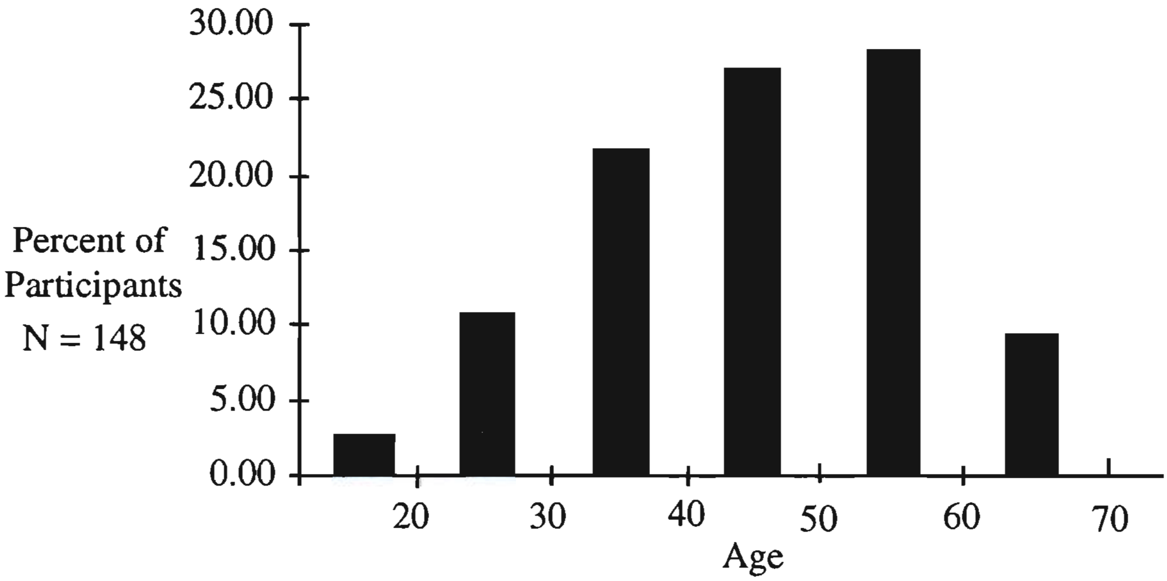
The educational background of participants was expected to directly affect the knowledge of participants. Part of the information requested from each participant included education level and major field of study or

Table 2. General descriptive characteristics of TEEAC program participants *

Characteristic	Frequency	Percent
Sex of Participant		
Female	124	83.8
Male	24	16.2
Age (Mean = 54.4 Range = 23 - 76)		
20 - 30	4	2.70
31 - 40	16	10.81
41 - 50	32	21.62
51 - 60	40	27.03
61 - 70	42	28.38
71 - 80	14	9.46
Ethnic Classification		
Caucasian	134	90.54
Native American	6	4.05
Hispanic	4	2.70
African-American	2	1.35
Other	2	1.35
Education Affiliation		
Teacher	124	83.78
Student	8	5.41
Scout Leaders	5	3.38
Administrator/Principal	2	1.35
Librarian	2	1.35
No Indication	7	4.73

* N = 148

Figure 1. Age distribution of TEEAC program participants



area of specialization (Table 3). Because TEEAC endorses teacher inservice programs, program participants were expected to have completed at least a Bachelor's degree. Indeed, 76.30% held Bachelor's degrees, 14.20% had advanced to the Master's level, and one (0.70%) had completed a Doctoral degree. The remaining respondents (8.80%) indicated they had some college education, but no college degree.

There was a great variety of responses to the question regarding participants' major field of study or area of specialization. The majority (63.77%) of the 138 participants responding indicated their major field of study was education related. Over 26% of the total responses indicated a natural science field of study or area of specialization. Forty percent of the responses indicated education and 34% indicated a field of study or area of specialization in subjects other than natural science.

Table 3. Education level, major fields of study and areas of specialization of TEEAC program participants

Characteristic	Frequency Response	Percent Responding	Percent of Total Responses
Education Level *			
Bachelor's Degree	113	76.30	76.30
Some college	13	8.80	8.80
Master's Degree	21	14.20	14.20
Doctoral Degree	1	0.70	0.70
	148		100.00
Fields of Study/Areas of Specialization**			
Education	88	63.77	40.37
Natural Sciences			
Biology	29	21.01	13.30
Geography	10	7.25	4.59
Earth Science/Geology	9	6.52	4.13
Life Science	4	2.90	1.83
Agricultural Science	3	2.17	1.38
Environmental Science	2	1.45	0.92
Liberal Arts	18	13.04	8.26
Science	17	12.32	7.80
Social Sciences	14	10.14	6.42
Math	13	9.42	5.96
Miscellaneous	11	7.97	5.05
	218		100.00

* N = 148 participants responding
** N = 138 teachers responding

Other information concerning the educational background of participants included natural science college credit and the number of TEEAC hours accumulated (Table 4). Although less than half of the participants had educational backgrounds related to a natural science, the majority (83.11%) had a least some college credit in a natural science subject. Most of the 148 participants (76.36%) had college credit in biology, but less than half had college credit in environmental science (43.92%) and plant science (43.92%). Participants with college credit in wildlife science comprised the smallest percentage (25.78%).

Three groups were formed on the basis of the number of hours taken for the analysis of differences in ecological vocabulary based on the number of natural science courses taken by the participants . One group had no environmental coursework, the second group had one to three hours of course work, and the third group had three or more hours.

Subjects and Grade Levels Taught by Teacher-Participants

Program participants were asked to indicate the grade level and subjects they taught (Table 5). Fifty-six of the 124 teachers responding taught more than one grade level, resulting in a total of 382 responses. Kindergarten through third grade comprised 17.79% of responses, fourth through sixth grade totaled 23.57%, seventh through ninth totaled 28.27%, and tenth through twelfth totaled 29.06%. College instructors comprised an additional 1.31%.

Table 4. Natural science college credit and TEEAC hours of TEEAC participants *

Characteristic	Frequency	Percent
College credit hours in Natural Science Subjects		
Environmental Science		
0	83	56.08
1 - 4	32	21.62
5 - 8	19	12.84
9 - 20	13	8.78
21+	1	0.68
Biology		
0	35	23.65
1 - 4	31	20.95
5 - 8	31	20.95
9 - 20	25	16.89
21+	26	17.57
Plant Science		
0	83	56.08
1 - 4	32	21.62
5 - 8	18	12.16
9 - 20	14	9.46
21+	1	0.68
Wildlife Science		
0	110	74.32
1 - 4	19	12.84
5 - 8	8	5.41
9 - 20	7	4.73
21+	4	2.70
Have no college credit hours in any of the above subjects	25	16.89
Have at least one college credit in the above categories	123	83.11
TEEAC Hours Accumulated		
0 - 6	115	77.70
7 - 12	2	1.35
13 - 19	11	7.43
20 - 26	6	4.05
27 - 33	10	6.76
34 - 40	0	0.00
41 to 45	3	2.03
>45	1	0.68

*N = 148

Table 5. Subjects and grades taught by TEEAC program teacher-participants

Characteristic	Frequency Response	Percent Responding	Percent of Total Responses
Grade Level Taught*			
Kindergarten	13	10.48	3.40
First	19	15.32	4.97
Second	13	10.48	3.40
Third	23	18.55	6.02
Fourth	32	25.81	8.38
Fifth	26	20.97	6.81
Sixth	32	25.81	8.38
Seventh	34	27.42	8.90
Eighth	40	32.26	10.47
Ninth	34	27.42	8.90
Tenth	37	29.84	9.69
Eleventh	38	30.65	9.95
Twelfth	36	29.03	9.42
Other	5	4.03	1.31
	382		100.00
Subjects Taught**			
All	41	34.45	26.28
Science	33	27.73	21.15
Liberal Arts	31	26.05	19.87
Math	15	12.61	9.62
Biology	12	10.08	7.69
Chemistry	8	6.72	5.13
Environmental Science	7	5.88	4.49
Earth Science	7	5.88	4.49
Geology	1	0.84	0.64
Agriculture	1	0.84	0.64
	156		100.00

* N = 124 teachers responding
** N = 119 teachers responding

When asked to list the subjects they taught, a total of 156 responses from 119 teachers were tabulated with 28 teachers listing multiple subjects. General science and natural sciences were the leading subjects taught by the responding teachers, comprising 44.23% of the total responses. Science was the largest single subject taught (21.15%). The natural science subjects of Biology (7.69%), Chemistry (5.13%), Environmental Science (4.49%), and Earth Science (4.49%), Geology (0.64%), and Agriculture (0.64%) comprised a total of 23.08% of the total responses. Over 24% of the responses indicated all subjects were taught. History, English, Social Studies, and Reading were combined into a Liberal Arts heading, comprising 12.61% of the responses.

Preferred Methods and Main Sources for Learning Ecology

Participants were asked to indicate their preferred methods for learning ecology (Table 6). Active methods comprised more than 80% of the 387 responses. These methods included hands-on, participatory workshops (33.33%), demonstration field days (26.87%), and personal contact with an ecologist (22.22%). Passive methods for learning ecology comprised just over 17% of the responses, including video/television (13.95%) and pamphlets/magazines (3.10%). However, when asked to list their main sources of ecological information, over 50% of the 300 participant responses were video/television (22.00%) and pamphlets/magazines (29.67%). A possible explanation for this discrepancy between the methods preferred by participants and the actual sources of learning may

Table 6. Preferred methods and main sources for learning ecology TEEAC program participants

Characteristic	Frequency Response	Percent Responding*	Percent of Total Responses
Preferred Methods for Learning Ecology			
Hands-on, Participatory Workshop	129	87.16	33.33
Demonstration Field Days	104	70.27	26.87
Personal Contact with Ecologist	86	58.11	22.22
Video/Television	54	36.49	13.95
Pamphlet/Book	12	8.11	3.10
Other	2	1.35	0.52
	387		100.00
Source of Ecological Information			
Magazines/Newspapers/Newsletters	89	60.14	29.67
Environmental Education Programs	79	53.38	26.33
Video/Television	66	44.59	22.00
Personal Contact with Ecologist	34	22.97	11.33
University Courses	27	18.24	9.00
Other	5	3.38	1.67
	300		100.00

* N = 148

be the lack of time (Ham and Sewing 1987) and the ease of acquiring ecological information by passive means.

Exposure to Environmental Science-Related Magazines

Three of the most easily acquired passive means of ecological information are newspapers, magazines, and newsletters, comprising 30% of the participants' source of ecology information. Participants were asked to list the environmental magazines to which they had subscribed in the last year. Twenty-two different magazines were tabulated from the 162 responses of 51 participants (Table 7).

Over 56% of respondents subscribed to magazines they received as a membership benefit to an environmental organization such as Audubon (14.20%), Nature Conservancy (12.35%), National Wildlife Federation (10.49%), and the National Parks and Conservation Association (9.88%). Nearly 15% of respondents subscribed to environmental education magazines including Ranger Rick (7.41%) and World (4.94%). Over 14% of respondents subscribed to traditional environmental science magazines including National Geographic (9.88%), Natural History (2.47%), and Smithsonian (1.23%). Over 10% of respondents subscribed to natural resource magazines, primarily Texas Parks and Wildlife (9.88%), and nearly 5% subscribed to magazines promoting environmental activism including Garbage (1.85%) and E Magazine (1.23%).

For analysis of change in ecological vocabulary, participants were clustered into two groups based on whether or not they subscribed to an environmental magazine.

Table 7. Environmental magazines subscribed to by TEEAC program participants one year prior to the program

Characteristic	Frequency Response	Percent Responding*	Percent of Total Responses
Audubon	23	45.10	14.20
Nature Conservancy	20	39.22	12.35
National Wildlife Federation	17	33.33	10.49
National Parks and Conservation Assoc.	16	31.37	9.88
National Geographic	16	31.37	9.88
Texas Parks and Wildlife	16	31.37	9.88
Sierra	13	25.49	8.02
Ranger Rick	12	23.53	7.41
World	8	15.69	4.94
Natural History	4	7.84	2.47
Garbage	3	5.88	1.85
E Magazine	2	3.92	1.23
Buzzworm	2	3.92	1.23
Smithsonian	2	3.92	1.23
Natural Science	1	1.96	0.62
Miscellaneous	7	13.73	4.32
	162		100.00

* N = 51 participants responding

Membership in Environmental Organizations

Additional exposure to environmental science was indicated by membership in environmental or environmental education organizations (Table 8). Seventy-eight participants indicated they belonged to one or more of 23 organizations for a total of 174 responses. Over 87% of the responses belonged to organizations which promote environmental issues and/or activism. The top five of these organizations were Audubon (13.22%), Nature Conservancy (11.49%), National Wildlife Federation (9.77%), National Parks and Conservation Association (9.20%), and Sierra Club (5.75%). Over 22% of the responses indicated membership in environmental/outdoor education teacher organizations, primarily the Texas Association for Environmental Education (10.92%) and the Texas Outdoor Education Association (10.34%).

For analysis of change in ecological vocabulary, participants were clustered into two groups based on whether or not they belonged to an environmental or environmental education organization.

Environmental Education and Ecology in the Classroom

Participants were asked the degree of environmental education integration in the classroom, and whether they taught ecology in the classroom. The intent of the two questions was to measure the test instrument's sensitivity to changes in ecological vocabulary based on what was taught in the classroom. However, the responses to these two questions (Table 9) also reveals an apparent discrepancy between an accepted tenet of environmental education and the use of environmental education in the classroom.

Knowledge of ecological concepts is well established as a distinct level of environmental education (Hungerford, Peyton, and Wilke, 1980). Seventy-five percent of the participants indicated they integrated environmental education into the classroom curriculum in some way. However, less than half (37%) indicated they taught any ecology in the classroom.

The most probable explanation for the smaller number of participants indicating ecology as a classroom subject is that ecology is a specific science subject, usually taught at the secondary level. The specificity of ecology as a classroom subject precludes a large number of participants indicating its use, particularly at the elementary grade level.

Environmental education, on the other hand, is often considered a curriculum supplement utilized within a wide range of grade levels and classroom subjects (Disinger and Monroe, 1994) and is therefore used by a larger number of participants.

This explanation is corroborated by the fact that all participants indicating they taught ecology were secondary science teachers whereas the participants indicating they integrated environmental education into the classroom covered a broad spectrum of grade levels and subjects taught.

Motivation for Attending TEEAC Endorsed Program

All 148 participants selected one or more of four reasons for participating in the TEEAC endorsed program for a total of 307 responses (Table 10). The top two responses were personal desire to improve teaching techniques (41.04%) and environmental convictions (31.27 %).

Table 8. TEEAC program participant membership in environmental and environmental education organizations

Characteristic	Frequency Response	Percent Responding*	Percent of Total Responses
Audubon	23	29.49	13.22
Nature Conservancy	20	25.64	11.49
Texas Association for Environmental Education	19	24.36	10.92
Texas Outdoor Education Association	18	23.08	10.34
National Wildlife Federation	17	21.79	9.77
National Parks and Conservation Association	16	20.51	9.20
Sierra Club	13	16.67	7.47
World Wildlife Fund	10	12.82	5.75
Texas Forestry Association	9	11.54	5.17
Earth First!	8	10.26	4.60
Ducks Unlimited	5	6.41	2.87
Texas Committee on Natural Resources	4	5.13	2.30
Gulf Coast Conservation Association	2	2.56	1.15
Greenpeace	1	1.28	0.57
Other	9	11.54	5.17
	174		100.00

* N = 78 participants responding

Table 9. Hours of classroom instruction in ecology by TEEAC program participants *

Characteristic	Frequency	Percent
Is Environmental Education a Part of Classroom Curriculum?		
Minor	63	42.57
Integral	48	32.43
None	37	25.00
Hours of Ecology Instruction		
0	64	43.24
1 - 10	14	9.46
11 - 20	13	8.78
21 - 30	7	4.73
31 - 40	6	4.05
41 - 50	4	2.70
50+	11	7.44
no response	29	19.59

* N = 148

Table 10. Motivation for attending TEEAC endorsed programs

Characteristic	Frequency Response	Percent Responding*	Percent of Total Responses
Personal Desire to Improve Teaching	126	85.14	41.04
Environmental Convictions	96	64.86	31.27
TEEAC Recognition	59	39.86	19.22
Required by Principal or School District	8	5.41	2.61
Other	18	12.16	5.86
	307		100.00

* N = 148

Ecological Vocabulary Survey Results

A series of 16 matching and 41 multiple choice statements were answered by participants before and after each TEEAC program. Average correct responses per person and per descriptive variable group are presented first, with average correct responses to statements following.

Overall Data Trends

For each of the 148 participants, the average number of correct statements, out of 57 statements, was 37.07 (65.04%) on the pre test, significantly increasing to 45.96 (80.63%) on the post test. The average increase between the pre and post test was 8.89 correct statements. The average number of correct pre and post statements and the average difference between correct pre and post statements are recorded at the top of Tables 11 - 15. This allows convenient comparison between the overall averages and the average number of correct statements of groups formed by general descriptive characteristics.

There was a significant gain between the pre and post test statements of all groups formed by descriptive variables. There were significant changes between correct pre test statements and correct post test statements within several variable groups, particularly variables describing participants' educational and teaching backgrounds.

In general, the subgroups with the smallest number of correct pre and post test statements were comprised of younger elementary school teachers, teaching all subjects, with no natural science background. This is consistent with findings by Bethel (1982). Conversely, the subgroups with the largest number of correct pre and post test statements were comprised of older secondary teachers teaching natural sciences and with a natural science background.

The subgroups with the lowest number of correct pre test statements had a larger increase in correct statements than the subgroups with the highest number of correct pre test statements. This indicates that the greatest gain in ecological vocabulary was made by the participants with the least amount of pre-program ecological knowledge.

General Descriptive Characteristic Groups

The average number of correct pre and post test statements for participants grouped according to age, gender, ethnicity is shown in Table 11. Ethnicity and age predicted significant differences in the amount ecological vocabulary known. On the average, minorities had significantly fewer correct answers on the pre test than Caucasians (31.58 vs. 37.78). The larger average difference between correct pre and post test statements for minorities (11.59 vs. 8.54) indicated a greater gain in ecological vocabulary, but this difference was not significant. Younger participants (23 - 50 years) had significantly fewer correct pre test statements than 51 - 76 year old participants (34.62 vs. 38.51). However, the average number of correct post test statements was not only nonsignificant, but greater (46.31 vs. 45.75). Accordingly, the average difference between correct statements (11.69 vs. 7.24) was significant.

Of all the descriptive variables, the formal educational background of participants predicted the most significant changes in correct statements (Table 12), with one exception. That exception is the groups formed by

Table 11. Average number of correct statements by TEEAC endorsed program participant groups defined by gender, age and ethnicity

Descriptive Variable/Subvariables	Group Size	Avg. Correct Statements* Pre-test	Post-test	Average Difference
All Participants, 57 Statements	N=148	37.07	45.96	8.89
Gender				
Male Participants	N=24	37.96	48.08	10.12
Female Participants	N=124	36.89	45.54	8.65
Ethnicity				
Caucasian	N=131	37.78^{x}	46.32	8.54
Minority	N=17	31.58^{y}	43.18	11.59
Age				
23 - 50 year old	N=52	34.62^{x}	46.31	11.69^{x}
51 - 76 year old	N=96	38.51^{y}	45.75	7.24^{y}

* there was a significant difference between all pre and post test responses within the same variable groups (alpha = .05)

^{xy} indicates that numbers in same column with different superscript are significantly different (alpha = .05)

Table 12. Average number of correct statements by TEEAC endorsed program participant groups defined by formal educational background

Descriptive Variable/Subvariables	Group Size	Avg. Correct Statements* Pre-test	Post-test	Average Difference
All Participants, 57 Statements	N=148	37.07	45.96	8.89
Education				
High School Degree	N=13	36.67	45.73^{x}	9.06
Bachelor's Degree	N=113	36.70	45.11^{x}	8.40
Master's Degree	N=21	38.88	49.76^{y}	10.88
Major Field of Study				
Elementary Education	N=23	29.43^{x}	40.56^{x}	11.13^{x}
Math and Liberal Arts	N=31	35.45^{x}	45.35^{y}	9.90^{y}
Natural and Traditional Science	N=74	42.29^{y}	49.54^{z}	7.25^{y}
Natural Science Course Work				
No Natural Science Courses	N=25	30.28^{x}	42.32^{x}	12.04^{x}
1-3 Hours in Natural Sciences	N=72	35.37^{y}	45.49^{y}	10.11^{x}
3+ Hours in Natural Sciences	N=51	42.72^{z}	48.41^{z}	5.69^{y}

* there was a significant difference between all pre and post test responses within the same variable groups (alpha = .05)

^{xyz} indicates that numbers in same column with different superscript are significantly different (alpha = .05) the highest degree earned which had only one significant change between the correct post test statements of participants with a Bachelor's and the post test statements of participants with a Master's degree (45.11 vs. 49.76). There were significant changes in the number of all correct pre and post test statements of the participants grouped by their major field of study. Those with an elementary education background had the lowest number of correct pre test statements (29.43), a percent score of 53%. This likely reflects the fact that ecology receives less emphasis in the elementary education pre-service curriculum. However, of all the groups formed by descriptive variables, this group had the second greatest average increase in correct statements (11.13). Conversely, the participants with a major field of study in natural and traditional sciences had the third highest number of correct pre and post test statements, 42.29 and 49.54.

There were significant changes in the average number of correct pre and post test statements of the participants grouped by natural science college credit. Those participants with 3 or more credit hours had the second highest number of correct pre test statements (48.41) and the second lowest gain (5.69). Conversely, the participants with no natural science course work had the second lowest number of correct pre test statements (30.28).

There were significant differences between variable groups formed by the grade level and subject taught (Table 13). Of the groups defined by the grade level taught, elementary school teachers had the lowest number of correct pre test statements (33.40). The secondary school teachers' average number of 43.73 correct pre test statements equaled the highest number of

Table 13. Average number of correct statements by TEEAC endorsed program participant groups defined by grade level and subject taught

Descriptive Variable/Subvariables	Group Size	Avg. Correct Statements* Pre-test	Avg. Correct Statements* Post-test	Average Difference
All Participants, 57 Statements	N=148	37.07	45.96	8.89
Grade Level Taught				
Elementary Grades	N=100	33.40^{x}	43.03^{x}	9.63
Middle School Grades	N=132	38.41^{y}	48.41^{y}	10.00
Secondary Grades	N=145	43.73^{z}	50.19^{y}	6.46
Not Teaching	N=27	36.04^{y}	44.44^{x}	8.4
Subjects Taught				
All Subjects Taught	N=38	32.85^{x}	43.03^{x}	10.18^{x}
Natural science subjects taught	N=61	43.73^{y}	49.30^{y}	5.58^{y}
Other subjects taught	N=57	37.36^{z}	47.08^{y}	9.72^{z}
Not teaching	N=25	36.04^{z}	44.44^{x}	8.40^{z}

* there was a significant difference between all pre and post test responses within the same variable groups (alpha = .05)

^{xyz} indicates that numbers in same column with different superscript are significantly different (alpha = .05) correct pre test answers of all variable groups, a percent score of 77%. The secondary school teachers also had the highest number of correct post test statements (50.19), a percent score of 88%. Of the groups defined by the subjects taught, the group that taught all subjects had the lowest number of correct pre test answers (32.85). This is most likely due to the fact that this group is entirely composed of elementary school teachers. In fact, this group's correct post test statements equaled the number of correct post test statements for elementary school teachers, 40.56, a percentage score of 71.16%. Participants with the largest average number of correct pre and post test statements (43.73 and 49.30) taught natural science subjects in the classroom. Coincidentally, the number of correct pre test statements equals that of secondary teachers, the group most likely to teach natural science subjects. It is also interesting to note that the teachers teaching all subjects and the elementary school teachers had fewer correct pre and post test statements than the group of participants indicating they were not teachers.

It was believed that application of ecological knowledge in the classroom, that is if ecology was taught in some way, would result in higher pre and post test scores. Therefore, variable groups were formed on the basis of how much environmental education and ecology was taught in class (Table 14). The participants indicating environmental education was an integral part of their classroom curriculum had a significantly higher number of correct pre test answers than participants indicating they had little or no environmental education integration (40.81 vs. 35.27). However, the latter group had a significantly higher gain in correct statements (9.96 vs. 6.67). Accordingly, there was no significant

Table 14. Average number of correct statements by TEEAC endorsed program participant groups defined by the integration of environmental education in the classroom

Descriptive Variable/Subvariables	Group Size	Avg. Correct Statements* Pre-test	Post-test	Average Difference
All Participants, 57 Statements	N=148	37.07	45.96	8.89
Integration of Environmental Education into Class Curriculum				
Integral	N=48	40.81^{x}	47.48	6.67^{x}
None to Minor	N=100	35.27^{y}	45.23	9.96^{y}
Is Ecology Taught in Class				
No	N=68	35.20^{x}	45.56	10.36
Yes	N=80	38.65^{y}	46.30	7.65
Amount of Ecology Taught in Class				
1-20 Hours of Ecology in Class	N=27	37.45	45.81	8.36
21+ Hours of Ecology in Class	N=28	37.89	47.32	9.43

* there was a significant difference between all pre and post test responses within the same variable groups (alpha = .05)

^{xy} indicates that numbers in same column with different superscript are significantly different (alpha = .05)

difference between the number of correct post test answers. This pattern was repeated between participants indicating they did and did not teach ecology in class (38.65 vs. 35.20), except there was no significant difference in gain of correct statements (7.65 vs. 10.36). There were no significant differences within the group defined by how much ecology was taught in class.

Participants that were active in various informal methods of learning ecology had a higher number of correct pre test statements than participants who were not active (Table 15). These methods include: subscriptions to environmental magazines; membership in environmental and environmental education organizations; and the amount of TEEAC endorsed program hours accrued. However, there were no significant differences between the average number of correct statements and the average gain in correct statements within the groups defined by these methods.

Responses to Individual Statements

The average number of correct responses to survey statements was expected to reveal if individual statements and the test design measured a change in ecological vocabulary. The statements and correct responses to the matching and multiple choice test designs are shown in Appendix C .

There was a positive difference between the number of correct pre and post test responses to all statements, with the exceptions of statements testing the vocabulary terms "carnivore" and "decomposer" (Table 16). In general, there was an inverse relationship between the number of correct pre test responses and the difference between correct pre and post test

Table 15. Average number of correct statements by TEEAC endorsed program participant groups defined by methods of learning ecology

Descriptive Variable/Subvariables	Group Size	Avg. Correct Statements* Pre-test	Post-test	Average Difference
All Participants, 57 Statements	N=148	37.07	45.96	8.89
Preference for Learning Ecology				
Active Only	N=30	35.30	46.17	10.87^{x}
Passive Only	N=14	31.78^{x}	44.64	12.86^{x}
Both	N=104	38.29^{y}	46.08	7.79^{y}
Subscription to Environmental Magazines				
At Least One	N=51	37.51	45.69	8.18
No Subscriptions	N=97	36.83	46.10	9.27
Membership in Environmental/EE Organizations				
At Least One	N=79	38.44	46.75	8.30
Not a member	N=69	35.49	45.05	9.56
TEEAC Hours Accumulated				
0-6 TEEAC Hours	N=115	36.35	45.68	9.33
7+ TEEAC Hours	N=33	39.57	46.94	7.36

* there was a significant difference between all pre and post test responses within the same variable groups (alpha = .05)

^{xy} indicates that numbers in same column with different superscript are significantly different (alpha = .05)

Table 16. Correct responses of all TEEAC participants to all Ecological Vocabulary Survey statements*

Statement Number	Ecological Vocabulary Term	Correct Response Pre-test	Post-test	Difference
1	carnivore	143	132	-11
2	commensalism	86	120	34
3	competition	90	121	31
4	producer, consumer, decomposer	135	129	-6
5	ecology	137	144	7
6	environment	142	143	1
7	omnivore	140	141	1
8	herbivore	139	143	4
9	mutualism	80	107	27
10	predation	92	114	22
11	symbiosis	76	106	30
12	parasitism	92	115	23
13	habitat	137	143	6
14	niche	118	134	16
15	diversity	90	107	17
16	biodiversity	92	109	17
17	abiotic (non living)	120	134	14
18	adaptation	115	138	23
19	biogeochemical cycle	70	102	32
20	biomass	52	93	41
21	biome	84	114	30
22	biosphere	118	131	13
23	carrying capacity	73	129	56
24	climate	106	122	16
25	community	116	139	23
26	density independent/dependent	47	90	43
27	ecosystem	100	135	35
28	edge effect	41	92	51
29	endemic	55	96	41
30	energy flow	54	108	54

continued

Table 16. Correct responses of all TEEAC participants to all Ecological Vocabulary Survey statements*

Statement Number	Ecological Vocabulary Term	Correct Response Pre-test	Post-test	Difference
31	entropy	37	88	51
32	evolution	74	96	22
33	extinction	114	128	14
34	fauna/flora	99	110	11
35	food chain	140	143	3
36	food web	93	138	45
37	gene pool	34	78	44
38	genotype	90	123	33
39	homeostasis	70	92	22
40	indicator species	94	130	36
41	indigenous	138	143	5
42	keystone species	58	78	20
43	law of tolerance	128	137	9
44	limiting factor	93	127	34
45	natural selection	91	94	3
46	nutrient	134	141	7
47	nutrient cycle	77	102	25
48	photosynthesis	139	146	7
49	population	91	122	31
50	producer, consumer, decomposer	113	135	22
51	productivity	51	92	41
52	resource (renewable, non-renewable)	91	118	27
53	species extinction	129	142	13
54	threatened species	110	128	18
55	succession	94	113	19
56	sustained yield	111	137	26
57	trophic	60	102	42
	Averages	96.41	119.60	23.19

* 148 participants, 57 survey statements

responses. That is, the lower the number of correct pre test responses, the higher the difference between correct pre and post test responses. The lowest increase in correct responses was 1, for the terms “environment and omnivore”, and the highest increase was 56, for the term "carrying capacity." The average number of correct pre test responses was 96.41, a percentage score 65.13%, and the average number of correct post test responses was 119.60, a percentage score of 81.08%. The average difference between correct pre and post test responses was 23.19.

These response figures are based on all 148 participants responding to all 57 survey statements, a total of 8436 responses. However, not all of the 57 ecological terms used in the survey were taught during any one program implementing the survey. Therefore, a more accurate indication of the survey measure of changes in ecological vocabulary, due to exposure to the TEEAC program, was derived from responses to statements containing ecological terms taught during the program, as indicated by the program facilitator (Table 17). There were 5162 responses to facilitator-selected statements, 61.20% of the total survey responses. This represents an average of 90.56 correct responses per survey statement. There was an increase in the number of correct responses to all facilitator-selected statements, except for the two mentioned above. One term, "decomposer", had no increase in correct responses and the term with the highest increase in the number of correct responses (54), was “carrying capacity." The average number of correct pre test responses was 61.12, a percent score of 67.49%, and the average number of correct post test responses was 79.51, a percent score of 87.80%.

Table 17. Correct responses of TEEAC participants to Ecological Vocabulary Survey statements selected by program facilitator as having been taught

No.	Vocabulary Term	Number of Participants*	Correct Response Pre-test	Post-test	Difference
1	carnivore	95	92	84	-8
2	commensalism	73	41	65	24
3	competition	82	43	73	30
4	decomposer	69	62	62	0
5	ecology	133	122	130	8
6	environment	133	127	128	1
7	omnivore	128	120	123	3
8	herbivore	55	50	54	4
9	mutualism	53	22	41	19
10	predation	109	66	82	16
11	symbiosis	53	19	40	21
12	parasitism	53	25	41	16
13	habitat	133	124	128	4
14	niche	59	42	56	14
15	biodiversity	60	40	52	12
16	species diversity	75	43	61	18
17	biotic and abiotic	124	103	116	13
18	adapting	133	103	123	20
19	biogeochemical cycles	52	26	44	18
20	biomass	133	45	85	40
21	biomes	119	70	97	27
22	biosphere	86	71	82	11
23	carrying capacity	133	64	118	54
24	climate	124	90	105	15
25	community	148	116	139	23
26	density dependent	53	12	41	29
27	ecosystem	148	100	135	35
28	edge	59	21	49	28
29	endemic	90	31	64	33
30	energy flows, matter cycles	82	22	72	50

continued

Table 17. Correct responses of TEEAC participants to Ecological Vocabulary Survey statements selected by program facilitator as having been taught

No.	Vocabulary Term	Number of Participants*	Correct Response Pre-test	Correct Response Post-test	Difference
31	entropy	58	12	47	35
32	evolution	60	27	43	16
33	extinction	90	68	80	12
34	flora and fauna	95	61	75	14
35	food chain	148	140	143	3
36	food web	148	93	138	45
37	gene pool	39	9	32	23
38	genotype	39	21	38	17
39	homeostasis	44	19	31	12
40	indicator species	59	33	54	21
41	indigenous	124	116	122	6
42	keystone	59	15	31	16
43	law of tolerance	109	93	100	7
44	limiting factors	124	76	106	30
45	natural selection	24	15	23	8
46	called nutrients	70	62	65	3
47	nutrient cycle	23	16	23	7
48	photosynthesis	120	111	118	7
49	population	133	86	114	28
50	producers, consumers, decomposers	120	90	111	21
51	productivity	67	21	46	25
52	resource (nonrenewable, renewable)	83	55	76	21
53	species extinction	119	103	113	10
54	threatened species	75	56	70	14
55	succession	73	49	63	14
56	sustained yield	124	92	114	22
57	trophic level	88	33	66	33
	Averages	90.56	61.12	79.51	18.39

* Number of participants which the combined program facilitators indicated were taught the term

To measure the amount of change in participants' ecological vocabulary, resulting from exposure to TEEAC endorsed programs, the average difference between the number of correct pre and post responses to facilitator-selected statements, 18.39, was compared with the average difference between the number of correct pre and post responses to all statements, 23.19. The inference is that 79.30% (18.39 of 23.19) of the correct responses were related to facilitator-selected statements. In other words, the Ecological Vocabulary Survey measured nearly 80% of the change in participants' ecological vocabulary resulting exposure to TEEAC programs. The remaining 4.80 (20.70%) average correct responses per statement not directly measured by the EVS may be attributed to vocabulary terms taught during the program but not selected by the facilitator and to correct guesses by the participants on the post test.

CONCLUSIONS AND RECOMMENDATIONS

Bennett (1987) emphasized that evaluation is necessary to convince the educational community that environmental education can improve the curriculum and make it more relevant to the students. He adds that proper evaluation requires reliable and valid evaluation instruments which consistently measure what they are suppose to.

Yambert (1975) concluded that "the clues to achieving and defining the ultimate goal of wise ecosystem use are to be found by examining and revising the words and concepts used to describe components and functions of the ecosystem."

A weakness in the TEEAC inservice scheme is its inherent lack of consistency and lack of evaluation tools necessary to ensure consistency. Because teachers may attend different and varied endorsed programs in order to accumulate the required forty-five contact hours, it is impossible to ensure a sequential, complete environmental education experience on a consistent basis. Of critical concern is that teachers acquire the ecological foundation on which environmental education is based. Evaluation and evaluation tools are required to ascertain this knowledge acquisition. This study evaluates an instrument designed to measure change in participants' ecological vocabulary resulting from exposure to TEEAC endorsed programs.

Conclusions as to the evaluation of the Ecological Vocabulary Survey instrument as related to the study objectives are presented below, with recommendations to TEEAC on utilizing the instrument as an evaluation tool. A revised Ecological Survey instrument is recommended in Appendix D.

Establishing an Ecological Vocabulary

The Ecological Vocabulary Survey (EVS) was developed from an 87 term ecological vocabulary list considered essential to environmental education. The list was ranked by state environmental educators (TEEAC site facilitators) and compared to lists developed for the North American Association for Environmental Education (NAAEE) and the British Ecological Society (BES).

Fifty-seven of the 87 terms ranked by TEEAC site facilitators were selected for the EVS. Fifty-two of the 57 EVS terms (91.23%) matched terms in either or both of the NAAEE and BES lists. Only 8 of the TEEAC survey terms, matching NAAEE or BES terms, were not included in the EVS. Therefore it was recommended that at least 52 of the EVS terms constitute a Basic Ecological Vocabulary (BEV) essential to environmental education. The BEV establishes a guideline for development and evaluation of environmental education programs oriented towards knowledge acquistion. It is further recommended that the 25 EVS terms matched by both NAAEE and BES terms comprise a Most Essential Ecological Terms category. The 27 EVS terms matched by either NAAEE or BES terms should comprise an Essential Ecological Terms category. It is recommended that the five EVS terms not matching NAAEE or BES terms be omitted from the EVS. There is no recommendation for adding any ecological terms.

Success of the Pre - Post Test Instrument

Measuring Changes in Ecological Vocabulary

Considered as a whole, the survey instrument was successful in gathering data which could be used to detect an increase in the correct responses to ecological vocabulary statements. The survey instrument was evaluated by comparing a treatment response, reflecting the number of vocabulary terms learned during the TEEAC program, with the average difference in all correct pre and post test responses. Assuming that no large amount of correct guessing took place, the Ecological Vocabulary Survey measured approximately 80% of the difference in all correct pre and post test responses resulting from exposure to the TEEAC program. That is, 8 out of 10 new vocabulary terms learned by a participant were recorded on the EVS.

Test Design

The Ecological Vocabulary Survey was comprised of a matching and a multiple choice test design. Although each section was successful in measuring changes in ecological vocabulary, there were weaknesses in the matching section design.

Because test responses were recorded on answer sheets which could be scanned by computer (see Test Design section of Methods), each statement was limited to 5 possible responses (letters a - e). To ease the test-taking process, the matching section was designed in 4 statement "blocks." In each block a matching term had 4 foils (letters a - d) and one "I don't know" selection (letter e). Appendix A shows an example of the block design. There was a "process of elimination" weakness in this test design. As the participants responded to each statement in a block there were fewer and fewer response selections. By first responding to known terms, participants increased their chances of correctly guessing at unknown terms. Despite encouragement to not guess, several participants commented that they used this process of elimination to select some of their answers.

The multiple choice section was comprised of a statement, 3 foils (letters a - c), and “I don’t know” selection (letter d). Comparing the average number of "I don't know" responses per statement in the two test sections provides some indication that the process of elimination method was used by participants. On the pre test, there was an average number of 11.00 "I don't know" responses in the matching section compared to 34.70 in the multiple choice section. There was an average of 1.44 “I don’t know” post test matching responses compared to 11.27 in the multiple choice section. Obviously, participants were attempting to answer more matching than multiple choice statements. Several factors may have caused this discrepancy between test designs including the number of known terms in each test design section. However, this factor may have only enhanced the process of elimination technique. In other words, if one of the four terms in a matching block were known, this would increase the chances of correctly guessing a term that was unknown.

The block test design would also reduce the flexibility of the instrument as an evaluation tool. Because each block of terms has a matching set of 4 responses the TEEAC program facilitators will be unable to select only those ecological terms they believe would be taught during their program.

For these reasons it is recommended that the matching test design be eliminated and new multiple choice statements be created for the ecological terms contained in the matching section.

Pre Test Questionnaire

The Ecological Vocabulary Survey was successful in gathering various demographic and antecedent variables which form relationships with the participants' ecological vocabulary. This information would be useful to TEEAC for evaluating environmental education programs. However, several variables collected more information than was useful for making comparisons. Also, the wording of some questions resulted in vague information, difficult to define.

Three questions should be altered to gather specific, clearly defined information. One question asked for the participants' major field of study or area of specialization. These two categories should be separate and each should include a list of possible replies. Several of the participants, particularly older participants, had difficulty remembering the number of natural science college credit hours. Therefore the response selection to this question should include a series of ranges, beginning with 0 (zero). Another question asking for the number of TEEAC hours accumulated should request a single reply rather than a series of ranges. Although the variable describing the amount of ecology taught in class did not predict a significant difference in correct responses, this information would provide a better understanding of the ecological foundation being laid for environmental education efforts. Teachers found it difficult to ascertain the number of hours dedicated to teaching ecology in the classroom, therefore the question should provide a selection of hourly ranges on a weekly basis.

A question addressing the participants' occupation should be added to the demographic questionnaire. The question asked for participants' preferences for learning ecology should be deleted due to lack of variation in response and lack of usefulness to TEEAC.

Recommendations for Implementation

The Ecological Vocabulary Survey may be implemented as an evaluation tool and as a database for developing environmental education programs and curricula. Revisions were made to increase flexibility in implementing the EVS as an evaluation tool. These revisions would allow TEEAC site facilitators to select individual vocabulary terms which are most likely to be taught during their programs. This would shorten the time it takes to implement a vocabulary evaluation instrument and may allow the instrument to be combined with another type of evaluation. It is recommended that the vocabulary term selection be required as part of the TEEAC site endorsement process. This would encourage site facilitators to consider ecological vocabulary during program development.

It is recommended that the Basic Ecological Vocabulary be utilized as a standard for teacher inservice providers and teachers to evaluate attainment of an ecological foundation essential to environmental education. The Most Essential and Essential categories of the Basic Ecological Vocabulary allows some flexibility in program and curriculum development and allows teachers to set feasible goals as they seek to achieve ecological and environmental literacy.

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APPENDICES

APPENDIX A

Pre- and Post-Program Survey Forms
Ecological Vocabulary Survey

Stephen F. Austin State University and the Texas Environmental Education Advisory Committee Ecological Vocabulary Survey

The Stephen F. Austin State University College of Forestry, in conjunction with the Texas Environmental Education Advisory Committee (TEEAC), is conducting a study of TEEAC endorsed programs and their participants.

The study intends to test an instrument designed to measure change in ecological knowledge. It is not an evaluation of the program you are attending nor is it an evaluation of your performance.

You can help us by completing the following Questionnaire and Ecological Vocabulary Survey:

Questionnaire

Name: ______________________________ Social Security #: ________________

INSTRUCTIONS
Indicate the most appropriate answer for each question on this form. When your have completed the questionnaire, begin your Ecology Vocabulary Pre-Survey.

1. Ethnic Classification:

a. ______ Caucasian
b. ______ African-American
c. ______ Hispanic
d. ______ Native American
e. ______ Other. Please Specify ___________ ________________________

2. Education Level:

a. ______ Bachelor's Degree
b. ______ Master's Degree
c. ______ Doctoral Degree

3. Major field of study or area of specialization? Specify __________

4. How many college credit hours have you completed in the following subject areas? (Please circle the appropriate number)

a. Environmental Science...	0	1	2	3	4	5	6	7	8	9	10	>10	(specify):
b. Biology..........................	0	1	2	3	4	5	6	7	8	9	10	>10	(specify)
c. Plant sciences	0	1	2	3	4	5	6	7	8	9	10	>10	(specify)
d. Wildlife sciences.........	0	1	2	3	4	5	6	7	8	9	10	>10	(specify)

5. How many TEEAC hours, if any, have your accumulated at this time? (Please circle the appropriate number)

0 - 6 7-12 13-19 20-26 27-33 34-40 41-45 >45

6. What grade level(s) do you teach?____________________________________

7. What subject(s) do you teach?____

8. Is environmental education presently part of your classroom curriculum? Please circle the appropriate response)

an integral part a minor part not a part

9. How do you like to learn about ecological concepts? (Check preferred methods)

______ A written pamphlet or a book
______ A video
______ Demonstration field days
______ A hands-on, participatory seminar or workshop
______ Personal contact with an ecologist or environmental educator
______ Some other means (please indicate) ______________________________

11. Is ecology presently a part of your classroom curriculum?
______ Yes ______ No

If yes, how many hours of instruction is dedicated to this subject?
____

12. Please list any environmental magazines which you have subscribed to in the past year:
______ Yes ______ No

13. Are you a member of, or do you support, any environmental or environmental/outdoor education organizations, such as:

______ Audubon Society other: __________________
______ Ducks Unlimited __________________
______ Earth First! __________________
______ National Parks and Conservation Association __________________
______ National Wildlife Federation
______ National Geographic Society
______ Nature Conservancy
______ Sierra Club
______ Texas Association for Environmental Education
______ Texas Committee on Natural Resources
______ Texas Forestry Association
______ Texas Outdoor Education Association

14. What motivated you to attend this TEEAC endorsed program? (you may check more than one response)

_______ Personal desire to improve teaching techniques

_______ Required by principal, school district, etc...

_______ Environmental convictions

_______ Desire to achieve TEEAC recognition

other ____

Thank You! You may begin the Ecological Vocabulary Pre-Survey

Ecological Vocabulary Pre-Test

INSTRUCTIONS

On SIDE TWO of your Answer Sheet, complete the sections labeled SEX, BIRTH DATE, and IDENTIFICATION NUMBER (your social security number).

Answer the questions on the Ecological Vocabulary Pre-Survey, recording your responses on SIDE ONE of your Answer Sheet

Return the Pre-Survey form, completed Questionnaire and Answer Sheet to your program facilitator.

Part 1: Matching

Please indicate the most appropriate answer for each question on your answer sheet. PLEASE DO NOT GUESS. If you do not know the answer, mark "e" on your answer sheet.

1 _____ Carnivore	a. a relationship between interacting organisms which benefits one organism but does not harm the other
2 _____ Commensalism	b. organism that feeds on dead material
3 _____ Competition	c. animal which eats other animals as its source of food
4 _____ Decomposer	d. a relationship with negative effects to both of the interacting organisms
5 _____ Ecology	a. animals which eat both plants and animals
6 _____ Environment	b. the total of an organism's surroundings
7 _____ Omnivore	c. animal which eat plants as its main source of food
8 _____ Herbivore	d. the study of the relationship between organisms and their environment
9 _____ Mutualism	a. a relationship in which one organism serves as a food source for another
10 _____ Predation	b. a relationship between two organisms, living in close association, in which both benefit
11 _____ Symbiosis	c. the living together of two or more species
12 _____ Parasitism	d. a relationship between two organisms, living in close association, which benefits one at the expense of the other

13 _____ Habitat	a. an organism's "occupation"
14 _____ Niche	b. the variety of species, their ecological functions, and the genetic variations they contain in an ecosystem
15 _____ Biodiversity	c. an organism's "home"
16 _____ Species diversity	d. the number of different species and their relative abundance in a given area

Part 2: Multiple Choice

Please indicate the most appropriate answer for each question on your answer sheet. PLEASE DO NOT GUESS. If you do not know the answer, mark **"d"** on your answer sheet.

17 The two broadest categories of things making up an ecosystems are -
a. climate and soil
b. herbivores and carnivores
c. living and non living things
d. don't know

18 Organisms may respond to environmental pressures such as drought, predation, parasitism, etc . . . by -
a. adapting
b. assimilating
c. selecting
d. don't know

19 Nutrients are recycled through systems via -
a. the ecology cycle
b. the environmental cycle
c. the air, water, carbon, nitrogen, phosphorus and sulfur cycles
d. don't know

20 Biomass is -
a. the sum weight and height of living things in an ecosystem
b. the height of living things in an ecosystem
c. the weight of living things in an ecosystem
d. don't know

21 Very large regions with characteristic vegetation and similar climates are
a. usually named after the climate
b. known as biomes
c. known as climax communities
d. don't know

22 The layer about Earth in which all living things exist is called -
a. the ecosystem
b. a habitat
c. the biosphere
d. don't know

23 The number of plants and animals which a given area can support is -
a. an optimum population size
b. the carrying capacity, or K
c. called exponential growth
d. don't know

24 Climate -
a. is temperature, humidity, precipitation, winds, and cloudiness at a given place and time
b. is the summation of weather conditions over a long period of time
c. has been scientifically proven to be altered by the greenhouse effect
d. don't know

25 A group of interacting plants and animals living in a given area is called a(n) -
a. population
b. cycle
c. community
d. don't know

26 If increasing population density slows population growth, then population growth probably -
a. is density independent and will follow a J-shaped growth curve
b. is exponential
c. is density dependent and will follow an S-shaped growth curve
d. don't know

27 An ecosystem is -
a. living communities and their non living environment functioning as a system
b. the transition zone between two different communities
c. living communities in an area interacting with each other
d. don't know

28 In ecological terms, an edge is -
a. the term used to describe dominance in a population
b. the beginning of the successional cycle
c. the place where two or more vegetation types meet
d. don't know

29 An endemic organism or population -
a. spreads diseases
b. is restricted to a given region
c. emigrates to other regions
d. don't know

30 Which of the following is true?
a. Both energy and matter cycle
b. Energy cycles and matter flows
c. Energy flows and matter cycles
d. don't know

31 The greatest percentage of the potential energy entering an ecosystem -
a. is used by plants in photosynthesis
b. becomes unusable (heat)
c. is recycled
d. don't know

32 _________ occurs when a population changes its characteristics over time, through natural selection, in response to changes in the environment.
a. adaptation
b. evolution
c. assimilation
d. don't know

33 Extinction is -
a. the disappearance of an individual plant or animal
b. the displacement of a plant or animal
c the complete disappearance of an species
d. don't know

34 Other names for plants and animals is -
a. carnivores and herbivores
b. flora and fauna
c. producers and decomposers
d. don't know

35 A deer eats a plant and is in turn eaten by a mountain lion. This sequence of events best describes a -
a. food web
b. food chain
c. trophic chain
d. don't know

36 The _____ concept describes complex feeding patterns for consumers in an ecosystem.
a. food web
b. food chain
c. trophic level
d. don't know

37 A critical factor in determining how populations respond to environmental pressures is-
a. the population gene pool
b. population adaptation
c. the climate
d. don't know

38 A critical factor in determining how organisms respond to environmental pressures is the organism's -
a. camouflage
b. flight distance
c. genetic make-up or genotype
d. don't know

39 Maintenance of nearly constant conditions in organisms or populations is called -
a. homeostasis
b. homeothermy
c. homeostability
d. don't know

40 Indicator species -
a. denote something about the ecosystem they are in
b. are threatened to become endangered
c. are threatened to become extinct
d. don't know

41 Plants and animals which occur naturally in an area (not introduced) are said to be -
a. confined
b. indigenous
c. endangered
d. don't know

42 A species that interacts with many others in the ecosystem and whose loss may lead to the disappearance of other species is known as a(n) ___ species.
a. keystone
b. indicator
c. dominant
d. don't know

43 When physical or chemical factors fall above or below levels which can be tolerated by a species, the species will -
a. decline in numbers, or redistribute, or cease to exist
b. not be affected
c. increase in numbers
d. don't know

44 Physical or chemical factors which limit the existence, growth, abundance, or distribution of an organism are called -
a. tolerance factors
b. limiting factors
c. natural selection factors
d. don't know

45 Organisms in a population die off because they cannot tolerate environmental stress. They are replaced by organisms which can tolerate these stresses, reproduce and pass on the tolerances to their offspring. This mechanism for evolutionary change is called -
a. adaptation
b. the law of tolerance
c. natural selection
d. don't know

46 Substances needed by organisms for normal growth and activity are -
a. called nutrients
b. always available in large amounts
c. usually available in small amounts
d. don't know

47 Most minerals return to the nutrient cycle -
a. through the carbon cycle
b. via photosynthesis
c. in the soil
d. don't know

48 The method in which green plants capture the energy of the sun is called -
a. respiration
b. transpiration
c. photosynthesis
d. don't know

49 A population is a group of individuals -
a. of the same kind living in the same place at the same time
b. may be divided into three ecological periods: young, reproductive, and old
c. randomly distributed over an area
d. don't know

50 The living portion of an ecosystem consists of -
a. producers, consumers, and decomposers
b. primary and secondary consumers
c. herbivores, carnivores, and omnivores
d. don't know

51 The rate at which energy is fixed, or stored, in an ecosystem is called -
a. biomass
b. productivity
c. consumerism
d. don't know

52 Examples of nonrenewable resources include -
a. wood, fish and game, fresh air and fertile soil
b. solar energy, wind energy, tidal energy
c. fossil fuels, uranium, phosphates and potassium
d. don't know

53 The major cause of the decline of threatened and endangered species is -
a. hunting
b. pollution
c. habitat destruction
d. don't know

54 A wild species considered likely to become endangered within the foreseeable future is-
a. considered extinct
b. immediately put on the Endangered Species List
c. classified as threatened
d. don't know

55 The process in which communities of plants and animals are replaced over time by a series of different communities is called -
a. succession
b. evolution
c. extinction
d. don't know

56 Sustained yield of a plant or animal population for human consumption requires -
a. exploitation
b. management
c. preservation
d. don't know

57 The total number of organisms that can be supported at each succeeding trophic (feeding) level -
a. increases drastically
b. increases slightly
c. decreases drastically
d. don't know

Any comments? Suggestions? ____

____

____

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Thank You! Please return all forms to your program facilitator

Ecological Vocabulary Post-Test

INSTRUCTIONS

Answer the questions on the Ecological Vocabulary Post-Survey, recording your responses on SIDE ONE of your Answer Sheet

Return the Post-Survey form and complete Answer Sheet to your program facilitator

Part 1: Matching

Please indicate the most appropriate answer for each question on your answer sheet. PLEASE DO NOT GUESS. If you do not know the answer, mark "e" on your answer sheet.

1 _____ Carnivore	a. a relationship between interacting organisms which benefits one organism but does not harm the other
2 _____ Commensalism	b. organism that feeds on dead material
3 _____ Competition	c. animal which eats other animals as its source of food
4 _____ Decomposer	d. a relationship with negative effects to both of the interacting organisms
5 _____ Ecology	a. animals which eat both plants and animals
6 _____ Environment	b. the total of an organism's surroundings
7 _____ Omnivore	c. animal which eat plants as its main source of food
8 _____ Herbivore	d. the study of the relationship between organisms and their environment
9 _____ Mutualism	a. a relationship in which one organism serves as a food source for another
10 _____ Predation	b. a relationship between two organisms, living in close association, in which both benefit
11 _____ Symbiosis	c. the living together of two or more species
12 _____ Parasitism	d. a relationship between two organisms, living in close association, which benefits one at the expense of the other
13 _____ Habitat	a. an organism's "occupation"
14 _____ Niche	b. the variety of species, their ecological functions, and the genetic variations they contain in an ecosystem
15 _____ Biodiversity	c. an organism's "home"
16 _____ Species diversity	d. the number of different species and their relative abundance in a given area

Part 2: Multiple Choice

Please indicate the most appropriate answer for each question on your answer sheet. PLEASE DO NOT GUESS. If you do not know the answer, mark "**d**" on your answer sheet.

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c. living and non living things
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a. increases drastically
b. increases slightly
c. decreases drastically
d. don't know

Any comments? Suggestions? ______________________________

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Thank You! Please return all forms to your program facilitator

Appendix B

Pre and Post Test Responses to Ecological Vocabulary Survey

Pre and Post Test Responses to Ecological Vocabulary Survey
Matching Statements

Question	Correct Response		Pre Test	Post Test
1 Carnivore	c. animal which eats other animals as its main source of food	a	0	2
		b	3	14
		<u>c</u>	<u>143</u>	<u>132</u>
		d	1	0
		e	1	0
2 Commensalism	a. relationship between interacting organisms which benefits one organism but does not harm the other	<u>a</u>	<u>86</u>	<u>120</u>
		b	3	5
		c	1	2
		d	27	18
		e	31	3
3 Competition	d. relationship with negative effects to both of the interacting organisms	a	34	24
		b	3	1
		c	5	2
		<u>d</u>	<u>90</u>	<u>121</u>
		e	16	0
4 Decomposer	b. organism that feeds on dead material	a	3	1
		<u>b</u>	<u>135</u>	<u>129</u>
		c	2	15
		d	4	3
		e	4	0
5 Ecology	d. the study of the relationship between organisms and their environment	a	5	3
		b	3	1
		c	1	0
		<u>d</u>	<u>137</u>	<u>144</u>
		e	2	0
6 Environment	b. the total of an organism's surroundings	a	2	3
		<u>b</u>	<u>142</u>	<u>143</u>
		c	1	1
		d	2	1
		e	1	0

7 Omnivore	a. animals which eat both plants and animals	**a**	**140**	**141**
		b	2	1
		c	3	4
		d	0	1
		e	3	1
8 Herbivore	c. animal which eat plants as its main source of food	a	3	4
		b	2	0
		c	**139**	**143**
		d	1	0
		e	3	1
9 Mutualism	b. a relationship between two organisms, living in close association, in which both benefit	a	5	5
		b	**80**	**107**
		c	41	33
		d	3	2
		e	19	1
10 Predation	a. a relationship in which one organism serves as a food source for another	**a**	**92**	**114**
		b	6	4
		c	1	3
		d	29	24
		e	20	3
11 Symbiosis	c. the living together of two or more species	a	2	4
		b	50	34
		c	**76**	**106**
		d	2	1
		e	18	3
12 Parasitism	d. a relationship between two organisms, living in close association which benefits one at the expense of other	a	41	28
		b	4	2
		c	1	0
		d	**92**	**115**
		e	9	3

13 Habitat	c. an organism's "home"	a	7	2
		b	2	1
		c	**137**	**143**
		d	1	2
		e	1	0
14 Niche	a. an organism's occupation	**a**	**118**	**134**
		b	6	5
		c	11	6
		d	3	1
		e	10	2
15 Biodiversity	b. the variety of species, and their ecological functions, the genetic variations they contain in an ecosystem	a	3	3
		b	**90**	**107**
		c	1	2
		d	34	32
		e	19	3
16 Species diversity	d. the number of different species and their relative abundance in a given area	a	7	3
		b	32	31
		c	0	2
		d	**92**	**109**
		e	16	3

Multiple Choice Statements

No	Statement and Foils	Pre Test	Post Test
17	The two broadest categories of things making up an ecosystems are -		
a.	climate and soil	9	6
b.	herbivores and carnivores	1	3
c.	living and non living things	**120**	**134**
d.	don't know	18	5

18	Organisms may respond to environmental pressures such as drought, predation, etc by		
a.	adapting	<u>**115**</u>	<u>**138**</u>
b.	assimilating	10	4
c.	selecting	4	3
d.	don't know	19	3
19	Nutrients are recycled through systems via -		
a.	the ecology cycle	21	19
b.	the environmental cycle	13	10
c.	the air, water, carbon, nitrogen, phosphorus and sulfur cycles	<u>**70**</u>	<u>**102**</u>
d.	don't know	44	17
20	Biomass is -		
a.	the sum weight and height of living things in an ecosystem	34	40
b.	the height of living things in an ecosystem	0	1
c.	the weight of living things in an ecosystem	<u>**52**</u>	<u>**93**</u>
d.	don't know	62	14
21	Very large regions with characteristic vegetation and similar climates are -		
a.	usually named after the climate	13	9
b.	known as biomes	<u>**84**</u>	<u>**114**</u>
c.	known as climax communities	0	6
22	The layer about Earth in which all living things exist is called -		
a.	the ecosystem	15	11
b.	a habitat	0	0
c.	the biosphere	<u>**118**</u>	<u>**131**</u>
d.	don't know	15	6
23	The number of plants and animals which a given area can support is -		
a.	an optimum population size	17	10
b.	the carrying capacity, or K	<u>**73**</u>	<u>**129**</u>
c.	called exponential growth	4	1
d.	don't know	54	8

24	Climate -		
a.	is temperature, humidity, precipitation, winds, cloudiness at a given place and time	31	20
b.	is the summation of weather conditions over a long period of time	**106**	**122**
c.	has been scientifically proven to be altered by the greenhouse effect	3	3
d.	don't know	8	3

25	A group of interacting plants and animals living in a given area is called		
a.	population	11	7
b.	cycle	3	0
c.	community	**116**	**139**
d.	don't know	18	2

26	If increasing population density slows population growth, then population growth		
a.	is density independent and will follow a J-shaped growth curve	1	12
b.	is exponential	4	7
c.	is density dependent and will follow an S-shaped growth curve	**47**	**90**
d.	don't know	96	39

27	An ecosystem is -		
a.	living communities and their non living environment functioning as a system	1	12
b.	the transition zone between two different communities	4	7
c.	living communities in an area interacting with each other	**47**	**90**
d.	don't know	96	39

28	In ecological terms, an edge is -		
a.	the term used to describe dominance in a population	7	9
b.	the beginning of the successional cycle	7	12
c.	the place where two or more vegetation types meet	**41**	**92**
d.	don't know	93	35

29	An endemic organism or population -		
a.	spreads diseases	7	5
b.	is restricted to a given region	**55**	**96**
c.	emigrates to other regions	9	15
d.	don't know	77	32

30	Which of the following is true?		
a.	Both energy and matter cycle	23	17
b.	Energy cycles and matter flows	9	9
c.	Energy flows and matter cycles	**54**	**108**
d.	don't know	62	14
31	The greatest percentage of potential energy entering an ecosystem -		
a.	is used by plants in photosynthesis	33	30
b.	becomes unusable (heat)	**37**	**88**
c.	is recycled	13	9
d.	don't know	65	21
32	______occurs when a population changes its characteristics, through natural selection, in response to changes in the environment.		
a.	adaptation	58	38
b.	evolution	**74**	**96**
c.	assimilation	9	7
d.	don't know	7	7
33	Extinction is		
a.	the disappearance of an individual plant oranimal	32	19
b.	the displacement of a plant or animal	1	1
c	the complete disappearance of an species	**114**	**128**
d.	don't know	1	0
34	Other names for plants and animals is		
a.	carnivores and herbivores	12	11
b.	flora and fauna	**99**	**110**
c.	producers and decomposers	25	21
d.	don't know	12	6
35	A deer eats a plant and is in turn eaten by a mountain lion. This sequence of events best describes a		
a.	food web	2	2
b.	food chain	**140**	**143**
c.	trophic chain	4	3
d.	don't know	2	2

36	The ____ concept describes complex feeding patterns for consumers in an ecosystem.		
a.	food web	**93**	**138**
b.	food chain	18	5
c.	trophic level	6	5
d.	don't know	31	0
37	A critical factor in determining how populations respond to environmental pressures is		
a.	the population gene pool	**34**	**78**
b.	population adaptation	54	43
c.	the climate	8	8
d.	don't know	52	19
38	A critical factor in determining how organisms respond to environmental pressures is		
a.	camouflage	6	7
b.	flight distance	0	2
c.	genetic make-up or genotype	**90**	**123**
d.	don't know	52	16
39	Maintenance of nearly constant conditions in organisms or populations is		
a.	homeostasis	**70**	**92**
b.	homeothermy	0	2
c.	homeostability	16	22
d.	don't know	62	32
40	Indicator species		
a.	denote something about the ecosystem they are in	**94**	**130**
b.	are threatened to become endangered	4	5
c.	are threatened to become extinct	1	1
d.	don't know	49	12
41	Plants and animals which occur naturally in an area (not introduced) are said to be		
a.	confined	4	3
b.	indigenous	**138**	**143**
c.	endangered	1	0
d.	don't know	5	2

42 A species that interacts with many others in the ecosystem and whose loss may lead to the disappearance of other species is known as a(n) _____ species.		
a. keystone	**58**	**78**
b. indicator	30	43
c. dominant	26	15
d. don't know	34	12

43 When physical or chemical factors fall above or below levels which can be tolerated by		
a. decline in numbers, or redistribute, or cease to exist	**128**	**137**
b. not be affected	4	1
c. increase in numbers	2	3
d. don't know	14	7

44 Physical or chemical factors which limit the existence, growth, abundance, or		
a. tolerance factors	17	14
b. limiting factors	**93**	**127**
c. natural selection factors	6	2
d. don't know	32	5

45 Organisms in a population die off because they cannot tolerate environmental stress.		
a. adaptation	24	24
b. the law of tolerance	**7**	**20**
c. natural selection	91	94
d. don't know	26	10

46 Substances needed by organisms for normal growth and activity are		
a. called nutrients	**134**	**141**
b. always available in large amounts	0	2
c. usually available in small amounts	3	2
d. don't know	11	3

47	Most minerals return to the nutrient cycle		
a.	through the carbon cycle	18	18
b.	via photosynthesis	7	4
c.	in the soil	**<u>77</u>**	**<u>102</u>**
d.	don't know	46	24

48	The method in which green plants capture the energy of the sun is called		
a.	respiration	4	0
b.	transpiration	2	2
c.	photosynthesis	**<u>139</u>**	**<u>146</u>**
d.	don't know	3	0

49	A population is a group of individuals		
a.	of the same kind living in the same place at the same time	**<u>91</u>**	**<u>122</u>**
b.	may be divided into three ecological periods: young, reproductive, and old	18	13
c.	randomly distributed over an area	12	7
d.	don't know	27	6

50	The living portion of an ecosystem consists of		
a.	producers, consumers, and decomposers	**<u>113</u>**	**<u>135</u>**
b.	primary and secondary consumers	2	2
c.	herbivores, carnivores, and omnivores	12	9
d.	don't know	21	2

51	The rate at which energy is fixed, or stored, in an ecosystem is called		
a.	biomass	11	20
b.	productivity	**<u>51</u>**	**<u>92</u>**
c.	consumerism	6	7
d.	don't know	79	29

52	Examples of nonrenewable resources include		
a.	wood, fish and game, fresh air and fertile soil	18	10
b.	solar energy, wind energy, tidal energy	17	12
c.	fossil fuels, uranium, phosphates and potassium	**<u>91</u>**	**<u>118</u>**
d.	don't know	22	8

53 The major cause of the decline of threatened and endangered species is		
a. hunting	5	2
b. pollution	6	3
c. habitat destruction	<u>**129**</u>	<u>**142**</u>
d. don't know	8	1

54 A wild species considered likely to become endangered within the foreseeable future is		
a. considered extinct	0	3
b. immediately put on Endangered Species List	23	16
c. classified as threatened	<u>**110**</u>	<u>**128**</u>
d. don't know	14	1

55 The process in which plant and animal communities are replaced over time by a series of different communities is called		
a. succession	<u>**94**</u>	<u>**113**</u>
b. evolution	25	21
c. extinction	1	1
d. don't know	28	13

56 Sustained yield of a plant or animal population for human consumption requires		
a. exploitation	0	1
b. management	<u>**111**</u>	<u>**137**</u>
c. preservation	15	5
d. don't know	22	5

57 The total number of organisms that can be supported at each succeeding trophic level		
a. increases drastically	5	8
b. increases slightly	6	7
c. decreases drastically	<u>**60**</u>	<u>**102**</u>
d. don't know	77	31

* correct pre and post test responses and percentage of correct responses are underlined

APPENDIX C

Revised Pre- and Post-Program Survey Forms

Texas Environmental Education Advisory Committee Ecological Vocabulary Survey

Please help us evaluate and improve environmental education in Texas by completing the following Questionnaire and Ecological Vocabulary Survey:

Questionnaire

Name: ______________________________ Social Security #: ________________

INSTRUCTIONS
Indicate the most appropriate answer for each question on this form. When your have completed the questionnaire, begin your Ecology Vocabulary Pre-Survey.

1. Ethnic Classification:

a. ______ Caucasian
b. ______ African-American
c. ______ Hispanic
d. ______ Native American
e. ______ Other. Please Specify ___________ ________________________

2. Education Level?

a. ______ Bachelor's Degree
b. ______ Master's Degree
c. ______ Doctoral Degree

3. Major field of study?

a. ______ Elementary Education
b. ______ Secondary Education
c. ______ Special Education
d. ______ Other. Please Specify____

4. Occupation?

a. ______ Teacher
b. ______ Teacher/Administrator
c. ______ Administrator
d. ______ Other. Please Specify____

5. How many college credit hours have you completed in the following subject areas? (Please circle the appropriate number)

a. Environmental Science...	0	1-3	4-6	7-10	>10	(specify)
b. Biology..........................	0	1-3	4-6	7-10	>10	(specify)
c. Plant sciences	0	1-3	4-6	7-10	>10	(specify)
d. Wildlife sciences.........	0	1-3	4-6	7-10	>10	(specify)

6. How many TEEAC hours, if any, have your accumulated? _ _____

7. What grade level(s) do you teach?____________________

8. What subject(s) do you teach?______________________

9. Is environmental education presently part of your classroom curriculum? Please circle the appropriate response)

an integral part   a minor part   not a part

10. Is ecology presently a part of your classroom curriculum?

______ Yes ______ No

If yes, how many hours of instruction per week is dedicated to this subject?

0-5 hrs.   6-10 hrs.   11-15 hrs.   16-20 hrs.   20+hrs.

11. Please list any environmental magazines which you have subscribed to in the past year:

______ Yes ______ No

12. Are you a member of, or do you support, any environmental or environmental/outdoor education organizations, such as:

______ Audubon Society   other: ____________
______ Ducks Unlimited   ____________
______ Earth First!   ____________
______ National Parks and Conservation Association   ____________
______ National Wildlife Federation
______ National Geographic Society
______ Nature Conservancy
______ Sierra Club
______ Texas Association for Environmental Education
______ Texas Committee on Natural Resources
______ Texas Forestry Association
______ Texas Outdoor Education Association

13. What motivated you to attend this TEEAC endorsed program? (you may check more than one response)

______ Personal desire to improve teaching techniques
______ Required by principal, school district, etc...
______ Environmental convictions
______ Desire to achieve TEEAC recognition

other ______________________________________

Thank You! You may begin the Ecological Vocabulary Pre-Survey

Ecological Vocabulary Pre-Test

Please answer the following statements and return your answers and the completed Questionnaire to your program facilitator.

PLEASE DO NOT GUESS.

1 A relationship between interacting organisms which benefits one organism but does not harm the other is
a. harmless
b. commensalism
c. predation
d. don't know

2 An animal which eats other animals as its source of food is called a
a. carnivore
b. omnivore
c. primary producer
d. don't know

3 An organism that feeds on dead material is called a
a. predator
b. primary consumer
c. decomposer
d. don't know

4 A relationship with negative effects to both of the interacting organisms is
a. competition
b. unnatural
c. mutualism
d. don't know

5 Animals which eat both plants and animals are called
a. vegetarian
b. omnivores
c. healthy
d. don't know

6 The total of an organism's surroundings is called its
a. environment
b. niche
c. home base
d. don't know

7 Animals which eat plants as their main source of food
a. are healthier
b. are called herbivores
c. are decomposers
d. don't know

8 The study of the relationship between organisms and their environment is
a. called ecosystem management
b. called ecology
c. environmental education
d. don't know

9 The living together of two or more species
a. results in speciation
b. is called symbiosis
c. is called competition
d. don't know

10 A relationship between two organisms, living in close association, which benefits one at the expense of the other
a. is parasitism
b. develops a superior species
c. is predation
d. don't know

11 Predation is
a. a relationship in which one organism serves as a food source for another
b. a short term relationship
c. cruel to the prey
d. don't know

12 An organism's "occupation" is called its
a. home
b. niche
c. job
d. don't know

13 the variety of species, their ecological functions, and the genetic variations they contain in an ecosystem is known as
a. species diversity
b. genetic drift
c. biodiversity
d. don't know

14 An organism's "home"
a. is its habitat
b. is where its heart is
c. is its castle
d. don't know

15 The number of different species and their relative abundance in a given area is called
a. a lot of species
b. species diversity
c. a census
d. don't know

16 The two broadest categories of things making up an ecosystems are -
a. climate and soil
b. herbivores and carnivores
c. living and non living things
d. don't know

17 Organisms may respond to environmental pressures such as drought, predation, parasitism, etc . . . by -
a. adapting
b. assimilating
c. selecting
d. don't know

18 Nutrients are recycled through systems via -
a. the ecology cycle
b. the environmental cycle
c. the air, water, carbon, nitrogen, phosphorus and sulfur cycles
d. don't know

19 Biomass is -
a. the sum weight and height of living things in an ecosystem
b. the height of living things in an ecosystem
c. the weight of living things in an ecosystem
d. don't know

20 Very large regions with characteristic vegetation and similar climates are
a. usually named after the climate
b. known as biomes
c. known as climax communities
d. don't know

21 The layer about Earth in which all living things exist is called -
a. the ecosystem
b. a habitat
c. the biosphere
d. don't know

22 The number of plants and animals which a given area can support is -
a. an optimum population size
b. the carrying capacity, or K
c. called exponential growth
d. don't know

23 Climate -
a. is temperature, humidity, precipitation, winds, and cloudiness at a given place and time
b. is the summation of weather conditions over a long period of time
c. has been scientifically proven to be altered by the greenhouse effect
d. don't know

24 A group of interacting plants and animals living in a given area is called a(n) -
a. population
b. cycle
c. community
d. don't know

25 If increasing population density slows population growth, then population growth probably -
a. is density independent and will follow a J-shaped growth curve
b. is exponential
c. is density dependent and will follow an S-shaped growth curve
d. don't know

26 An ecosystem is -
a. living communities and their non living environment functioning as a system
b. the transition zone between two different communities
c. living communities in an area interacting with each other
d. don't know

27 In ecological terms, an edge is -
a. the term used to describe dominance in a population
b. the beginning of the successional cycle
c. the place where two or more vegetation types meet
d. don't know

28 An endemic organism or population -
a. spreads diseases
b. is restricted to a given region
c. emigrates to other regions
d. don't know

29 Which of the following is true?
a. Both energy and matter cycle
b. Energy cycles and matter flows
c. Energy flows and matter cycles
d. don't know

30 _________ occurs when a population changes its characteristics over time, through natural selection, in response to changes in the environment.
a. adaptation
b. evolution
c. assimilation
d. don't know

31 Extinction is -
a. the disappearance of an individual plant or animal
b. the displacement of a plant or animal
c the complete disappearance of an species
d. don't know

32 A deer eats a plant and is in turn eaten by a mountain lion. This sequence of events best describes a -
a. food web
b. food chain
c. trophic chain
d. don't know

33 The _____ concept describes complex feeding patterns for consumers in an ecosystem.
a. food web
b. food chain
c. trophic level
d. don't know

34 A critical factor in determining how populations respond to environmental pressures is-
a. the population gene pool
b. population adaptation
c. the climate
d. don't know

35 A critical factor in determining how organisms respond to environmental pressures is the organism's -
a. camouflage
b. flight distance
c. genetic make-up or genotype
d. don't know

36 Maintenance of nearly constant conditions in organisms or populations is called -
a. homeostasis
b. homeothermy
c. homeostability
d. don't know

37 Indicator species -
a. denote something about the ecosystem they are in
b. are threatened to become endangered
c. are threatened to become extinct
d. don't know

38 A species that interacts with many others in the ecosystem and whose loss may lead to the disappearance of other species is known as a(n) ___ species.
a. keystone
b. indicator
c. dominant
d. don't know

39 When physical or chemical factors fall above or below levels which can be tolerated by a species, the species will -
a. decline in numbers, or redistribute, or cease to exist
b. not be affected
c. increase in numbers
d. don't know

40 Physical or chemical factors which limit the existence, growth, abundance, or distribution of an organism are called -
a. tolerance factors
b. limiting factors
c. natural selection factors
d. don't know

41 Organisms in a population die off because they cannot tolerate environmental stress. They are replaced by organisms which can tolerate these stresses, reproduce and pass on the tolerances to their offspring. This mechanism for evolutionary change is called -
a. adaptation
b. the law of tolerance
c. natural selection
d. don't know

42 Substances needed by organisms for normal growth and activity are -
a. called nutrients
b. always available in large amounts
c. usually available in small amounts
d. don't know

43 The method in which green plants capture the energy of the sun is called -
a. respiration
b. transpiration
c. photosynthesis
d. don't know

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a. of the same kind living in the same place at the same time
b. may be divided into three ecological periods: young, reproductive, and old
c. randomly distributed over an area
d. don't know

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b. immediately put on the Endangered Species List
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d. don't know

50 The process in which communities of plants and animals are replaced over time by a series of different communities is called -
a. succession
b. evolution
c. extinction
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51 Sustained yield of a plant or animal population for human consumption requires -
a. exploitation
b. management
c. preservation
d. don't know

52 The total number of organisms that can be supported at each succeeding trophic (feeding) level -
a. increases drastically
b. increases slightly
c. decreases drastically
d. don't know

Any comments? Suggestions? ____________________

Ecological Vocabulary Post Test

Please answer the following statements and return your answers and the completed Questionnaire to your program facilitator.

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Any comments? Suggestions? ______________________________

____

____

VITA

James L. Isleib was born in Pasadena, Texas on March 18, 1956, the son of Harvey R. and Ruby L. Isleib. After receiving his diploma from Galena Park High School, Galena Park, Texas in 1974, he enrolled in the School of Forestry at Stephen F. Austin State University in Nacogdoches, Texas. He received his Bachelor of Science in Forestry, with an emphasis in Interpretation in December, 1979. In January, 1980 he began employment as a Field Instructor for the YO Ranch Outdoor Awareness Programs in Mountain Home, Texas. He was promoted to Assistant Director in June, 1981, the position he held until his departure in August, 1989 when he accepted the Executive Director position of the Stephen F. Austin State University College of Forestry Piney Woods Conservation Center. The following spring, he enrolled in the Graduate School of Stephen F. Austin State University and began work on the Master of Science in Forestry. Jim has been married since 1979 to the former Diane Leslie Shell of Houston, Texas. They have two children, Melanie, born in 1988, and Jesse, born in 1992.

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The style manual for this thesis was the Journal of Forestry
This thesis was typed by James L. Isleib